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In the May number will appear:

The development of botany in Germany during the nineteenth century, by PROF. DR. EDUARD STRASBURGER, *Bonn, Germany.* Authorized translation by DR. GEO. J. PIERCE, *Cambridge, Mass.*

The embryo-sac of Aster Novæ-Angliæ, by CHAS. J. CHAMBERLAIN, *University of Chicago.*

Some recent cell literature, by DR. J. E. HUMPHREY, *Johns Hopkins University, Baltimore.*

Present problems in the morphology and biology of the Cactaceæ *will be concluded.*

BOTANICAL GAZETTE

APRIL, 1895.

Present problems in the anatomy, morphology, and biology of the Cactaceæ.

W. F. GANONG.

In this paper I purpose to discuss briefly the subject outlined by the above title, pointing out in particular those questions which can be settled only by study in the field, as well as those which require specially-collected field-material for their solution in the laboratory. The subject can be the more clearly understood and its importance the better judged if I give first a brief description of the anatomical, morphological, and biological characteristics of the family, and then add a short account of progress to our present state of knowledge.

The Cactaceæ form a sharply-defined, although phylogenetically very new, practically entirely American order, including some 1,000 usually badly-defined species grouped in some twenty worse-defined genera. Taken as a whole they exhibit a more extreme deviation from the normal in habits, and therefore in structure, than is to be found in any other large family of flowering plants; they offer in consequence many inviting problems, and as well an unusually favorable opportunity to test some of the great principles which are concerned with the nature of adaptation and the dynamics of development.

For the most part the Cactaceæ are dwellers in the desert and therefore economizers of water. To store water and to protect it from evaporating under the too-great power of the sun, requires a condensed form and this characteristic dominates throughout the order, showing its traces even in those species which have abandoned the desert habit. Containing often the only water-supply upon the desert, they are particularly liable to destruction by thirsting animals, and protection against them explains the presence of the nearly universal spines, the second marked characteristic of the order.

The roots, protected somewhat from the extreme conditions prevailing above ground, have not been found to show notable peculiarities. They often run very deep, are often tuberous for water-storage, are rarely aerial. But in the shoot the necessity for condensation, i. e., for surface reduction in proportion to bulk, has operated to lessen, even to the point of suppression, the branching and leaf-formation, has brought about very special form-conditions, probably unique relations of stem, leaf and axillary bud, and a very finely-adapted series of water-holding tissues.[1]

As to the tissues, it is enough here to say that the characteristic xerophilous appearances are a strong cuticle, thick epidermis, perfect cork, sunken stomata; collenchymatous hypoderma; deep palisade layers; great development of pith and cortex which consist of large round splendidly pitted water-storing cells, often containing mucilage; a fibro-vascular system in general simple in its make-up, lacking annual rings, composed as to its xylem part of strongly ringed and spiralled tracheids which are often collected into gland-like masses, the whole system conforming closely to the external form and following its morphological changes.

In external form, there is every variation from the leafy shrubby Peireskia to the ribbed columns of Cereus, the flat joints of the Platopuntiæ, the phyllocladia of Epiphyllum, or the tubercled spheres of Mamillaria, and everywhere are clusters of spines, in definite relation to which arise the flowers and new branches. How is this medley of structures to be brought into homology with the ordinary stem and leaf condition of other flowering plants? Happily these questions have been mostly solved. All Cactaceæ have leaves which show instead of the ordinary division into blade, petiole, etc., a division into blade and swollen base flattened to the stem.[2] The blade may persist for a season as in Peireskia, fall away early as is usual in Opuntia, remain very small as in Cereus, or microscopic as in Mamillaria. The axillary bud develops, not strictly in the axil, but upon the leaf-base, having been

[1] I am in the agnostic stage on the subject of the nature of the development of adaptations, but I retain the teleological phraseology for its convenience.

For the latter reason also I retain a distinction between anatomy, morphology, and biology, though I know they are not three branches of inquiry, but three phases of one, the first asking what a structure is, the second by what steps it has come to be what it is, and the third why it is what it is.

[2] A xerophilous characteristic, found also in Euphorbiaceæ and others.

forced to this position doubtless as a result of condensation of leaf-bases at the vegetative point. Leaf-base and axillary bud grow henceforth as one structure together and form the tubercle which attains its highest form in Mamillaria and Leuchtenbergia, and numbers of which merging together in vertical rows, sometimes with the cooperation of the stem added, form the ribs of the ribbed forms. Tubercle and rib physiologically replace the lost leaves, and varying in height and form allow of adaptive increase or decrease in spread of green surface, which is all in the xerophilously advantageous vertical direction. The spines are metamorphosed leaves, originating dorsiventrally on the sunken hair-protected axillary vegetative points, which may either be carried up entire by the growth of the tubercles and come to stand finally on their tips, as in Opuntia, Cereus, Echinopsis, Leuchtenbergia, etc., or they may split into two parts as in some divisions of Echinocactus and Mamillaria, one part going up on the tubercle and producing spines, the other remaining behind in or near the axil to produce a flower or a branch.[3] The flowers, produced rapidly during or at the close of the rainy season do not share the vicissitudes of the stem, and show no special adaptations to the dry climate. The ovary is deeply sunken in the flower-bearing stem, and the fruit, though often dry, is usually an edible berry, ensuring the best method of dispersal and conditions for germination in a dry climate. The seedlings are also succulent, with a spread of surface corresponding in a general way to that of the adult plants.

I have elsewhere traced briefly the steps by which this knowledge has been won.[4] The only work upon the comparative anatomy of the order is Schleiden's celebrated treatise of 1845,[5] which despite some errors peculiar to that time, clearly outlined the essential features of the subject. Von Mohl studied their bundle-systems, and many later students have gone to them for special points, all of which may be traced in the work of DeBary,[6] since which little of importance has appeared, for the golden age of anatomy is not in

[3] The full discussion of the points here outlined may be found in my paper, "Beiträge zur Kenntniss der Morphologie und Biologie der Cacteen" in Flora, Ergänzungsband, 1894.

[4] Flora, loc. cit.

[5] For titles, etc., see Flora, loc. cit.

[6] Comparative Anatomy of Phanerogams and Ferns.

these days. As to their morphology most systematists have given it some, though usually it has been scanty attention. De Candolle appears to have begun the attempt to determine the homologies of spine and tubercle and the other riddles of the group; various others, including Kauffmann, Vöchting, Schumann and Wetterwald, and above all Goebel, have debated point after point, and gradually won the truth. Finally I must be permitted to mention my own studies which in ground well prepared by my predecessors were made productive under the guidance of my teacher Goebel. It remains to mention the sources of our knowledge of their biology, and here we have but a single source to refer to, the groundwork for all future studies of this character, Goebel's discussion of their form, protection, and other conditions in his "Pflanzenbiologische Schilderungen."

So much for the characters of this attractive family and the pioneers in its study. What now remains for other explorers?

There is need first and most important of all, an exact investigation into the meteorological and biological conditions under which the Cactaceæ live. An all the year round study of the amount and time of rainfall, dew-formation, dryness of the air, winds, extremes and means of day and night and seasonal temperature,[7] intensity and amount of light, the kinds and habits of enemies and of cross-pollinating and disseminating friends, the exact situations in which they grow and the nature of the soil, all these must be known about any given district before we can more than guess at the "adaptations" in the Cactaceæ which inhabit it. Excepting for some incidental study by Goebel in Venezuela and the work of Stahl in Mexico last summer, the results of which we have yet to learn, no trained biologist has worked upon them in the field.

Taking first the simpler problems, there are several in which additional evidence is to be expected. It has been clearly shown that the spines of the Cactaceæ are metamorphosed leaves, and not "emergences" as some have claimed. The evidence is drawn from the occurrence of normal transitional structures which are formed by the axillary vegetative points as they begin to sprout into branches, i. e., after they

[7] The only data of this kind are those given by Coville (Contrib. Nat. Herb. **4**: 33-35. 1894), and these are scanty and for only one locality.

cease to form spines and before they begin to form leaves.[8] These transitions have been found in Opuntia and Echinopsis. Do they occur in other genera? Do they occur on the bases of flower-branches? Do any monstrosities, between leaf and spine, occur?

In the genus Opuntia and confined to it, in addition to the spines, occur the fine barbed bristles, produced on the inner side of the axillary vegetative point. Transitions between these and the spines are to be found on old sprouts of some Opuntias and the two are doubtless homologous. Are transitional forms elsewhere to be found?

The spines of many forms are white in color and weak in texture, even to becoming hair-like as in *Pilocereus senilis* and many others. The epidermal cells of such spines are usually provided with openings through which water may be seen under the microscope to be eagerly absorbed, the air causing the whiteness being expelled, but no trace of a tissue for conducting such water to the living parts has been found. Why do the epidermal cells absorb water? Is it conducted into the stem? The spines of Echinocactus species show a marked cross-banding, due to alternation of clearer and opaquer bands, the former being of larger diameter than the latter. The microscope shows that the cell-cavities in the darker bands contain air, while the clearer lack it. This seems to be an incidental growth condition. Upon what does it depend? What relation do the bands bear to the age of the spine? In the Cylindropuntiæ, each spine is commonly covered by a thin easily separable sheath. This has been found to consist morphologically of a layer of hairs grown together.[9] It cannot be necessary to protect the spine in its development, for others grow equally well without it. Is it of use or was it formerly of use? Is it a growth phenomenon? In some Mamillarias the epidermis of the spines extends out into hairs so that they become feather-like, and this is the common form for them in the seedlings throughout the family. Why are they of this form? Do they help to prevent evaporation?

Very little is known of the biology of the spines. It is assumed that the strong ones protect the plants against animals

[8] These may be found only when the branches are very young, indeed just as they first show signs of appearance, for the transitional leaf-spines wither and fall off very early.

[9] The discussion of this together with the other topics here mentioned may be found in my above cited paper in "Flora."

and that the bristles, easily separable, rankle in flesh the of an enemy and impress its memory with the dangerous character of that plant. But what purpose do the hooked ends of the spines so commonly found serve? Do they tear rather than prick an enemy? The spines show a great variety of arrangements; are these adaptive to the mode of attack of enemies? Very often there is a strong central spine pointing downwards, suggesting that it is to prevent a hoof from overturning the plant. In other cases, as in *Echinocactus hypacanthus* it points upward, suggesting that the plant may grow in hollows. In very many cases, as in Leuchtenbergia, species of Opuntia, and others, the spines become flat and papery and useless for protection. Of what use are they? In other cases they become flexible hairs. What useful end do they then serve? Is it possible that the strong protective spines occur upon the less extreme desert forms which live where large animals roam, and that these become hairs in the extreme deserts or elsewhere where enemies are rare and need for protection from loss of water is greater? In fact, do hairs and hair-like spines help materially to prevent such loss? Or may it not be that they reflect and refract the too intense rays of the sun and mitigate its force for the green tissues?[10] Can a line be drawn between the hair-like spines, and the morphologically very different multicellular hairs? In Peireskia, some of the spines serve as hooks for climbing. What other uses and forms of them are found? It is plain that Geddes' ebbing-vitality theory for the origin of spines does not apply in this vigorous group, nor is it likely that they are a direct result of dry climate as Lothelier would have us believe. Nowhere in nature is there a better place to test the dynamics of spine production than in this family.

In the genera Mamillaria, Cereus, Rhipsalis, and Opuntia, species[11] have been found which exude nectar in large clear drops from glands among the spines. These are particularly plain in *O. arborescens.* These glands have been proven to be spines more or less metamorphosed. Do they occur in other genera? The exudation takes place only while new parts are being formed. What is its use? Are ants attracted

[10] Or as Coville (op. cit.) suggests, they may permit too great radiation on the cold nights.

[11] A list of the known species is given in Flora, loc. cit. Nearly every species of Opuntia I have examined, eighteen in all, showed this nectar secretion.

by it which protect the young growing parts against some creeping tissue-eating enemy?

The spines are believed to originate always strictly dorsiventrally from the vegetative point, thus agreeing with one method of production of leaves. This has been proven only for *Opuntia arborescens*. It is desirable to investigate this point in other species and genera. In Peireskia however the spine-production is nearly radial; in Opuntia it becomes dorsiventral, the large spines being produced upon the outer or leaf side of the axillary vegetative point, and the bristles upon the inner or stem side. The dorsiventrality becomes still more marked in Cereus, etc., where nothing, or only some multicellular hairs, is produced upon the inner side; still more so in those species of Echinocactus where the point splits into two parts, and yet more in Mamillaria where it splits into two parts, which separate entirely. Is there any case in which the outer part of the point in Mamillaria produces its spines radially, or are they all laid down dorsiventrally? That a strong central spine closes the growth, as sometimes stated, is altogether improbable.

In *Peireskia aculeata* a very early splitting[12] of the axillary point has been found, one part remaining upon the leaf base, the other being carried up by the young stem in its growth, an exact reversal of the condition in Mamillaria where, after the splitting, one part remains in the axil and the other is carried out by the growing tubercle. Is this condition found in other species of Peireskia? The lower point normally produces the new branch, but when it is destroyed, the upper one does so. From the descriptions it seems as if the flowers are produced from the upper. Is this true? In *P. aculeata*, it is possible that the axillary bud does not at first stand upon the leaf base as in other genera, but in the axil in contact with both leaf and stem. Is this true? It is difficult to understand how otherwise a part of the axillary vegetative point could be carried up by growth of the stem. The transition from Peireskia to Opuntia is perfectly gradual and there can be no doubt that Peireskia is the nearest of all living Cactaceæ to the original stem-form. In *P. aculeata* and *P. bleo* a single large leaf often appears in the center of the spine mass. It seems impossible that this is formed in any other way than

[12] This splitting of the point so often referred to, is, I believe, unique in this family. It is not a branching nor a bifurcation, but a division into two parts by the going over of some of its central meristem into permanent tissue.

by the vegetative point forming it from a papilla homologous with those of the spines. If this be so, it is, as Goebel points out, additional evidence of the leaf-nature of the spines. Is it so? Are any intermediate forms between spines and leaf produced between the two, or is the transition sudden? Do these same axillary points, after producing the leaves, again produce spines? If so, the homology of the two would be clear. It is important to find a transition between the splitting points of Peireskia and the non-splitting point often carried up by the tubercle in Opuntia.

Epiphyllum shows phenomena in its flower and branch production which are best to be interpreted as due to a splitting of the axillary or the main points. Does this occur? In Rhipsalis a splitting of the axillary into several secondary points does take place. Splitting of the point is now known in Peireskia, Rhipsalis, Echinocactus, Mamillaria, Anhalonium. Does it occur in any other genera?

Leuchtenbergia principis is the most interesting species in the family. Its tubercles have become almost leaf-like, and its axillary points carried up upon their tips so that both spines (here papery) and flowers are produced there. This habit removes it from Mamillaria to that section of Echinocactus in which there is no splitting of the point, but the whole is carried up on the tubercle. Yet Leuchtenbergia is said to put out sprouts from the lower part of the stem. Whence do these come, from purely adventitious bud-formation, or in reality is there a very early splitting of the point, the axillary part remaining a long time latent? The latter is very improbable, but if it occurs it would restore Leuchtenbergia to relationship with Mamillaria. Are the tubercles shed like leaves? The development of this plant is unknown, and will give interesting results.

The tubercles seem generally to act as assimilating organs, and their spread of green surface is readily controlled in amount by varying their height. In Opuntia, as Goebel has lately proven,[13] the production of the tubercle is intimately dependent upon light, not forming at all upon sprouts grown in darkness. He has also shown elsewhere[14] that when the tubercles are protected by a cephalium as in Cephalocereus, and in lesser degree in Melocactus, the union of leaf and ax-

[13] Flora **80**: 96-116. 1895.
[14] Pflanzenbiologische Schilderungen 92, 93.

illary sprout is less extreme than in those which are exposed, but it is a question to just what this is due. Can other cases be found in which tubercles are partially protected or darkened, and what is then their behavior? In flat Rhipsalis species, and some Echinocacti, the backs of the tubercles grow out into papillæ or into wings increasing the spread of surface. In *Cereus rostratus*, these wings are bent backward so that they form hooks enabling the plant to climb, and *C. McDonaldiæ* shows an intermediate condition. Do the tubercles, or the wings from them, serve any other purposes in the family?

In some Echinocacti and Mamillariæ, a deep hair-filled groove unites the spine-bearing and the flower-bearing parts of the split axillary point. This groove is simply the greatly drawn-out sunken area in which the vegetative point is always protected. In the highest *Mamillariæ* however this groove is absent, which is because the splitting of the point occurs before the sunken area, or rather its raised walls, are formed, and each part of the point forms its own wall. *M. macrothele* seems to form an intermediate condition, for the groove is sometimes present, and sometimes not, but in reality it has a groove of which the edges grow together. Are there cases in which the groove persists as a sunken tube? Or are there other transitional forms? The genus Anhalonium though so small has both grooved (*A. fissuratum*) and ungrooved (*A. prismaticum*) forms, a curious case of "parallel-bildung" with Mamillaria, for we cannot suppose that the former came off from the grooved and the latter from grooveless Mamillariæ.[15]

[15] By a very natural mistake in the absence of a study of its embryology, Engelmann and (following him) Coulter have misunderstood the morphology of the tubercles in *Anhalonium*, and especially in that section of *Echinocactus* which the latter has elevated to generic rank under the name of *Lophophora* (Preliminary Revision of the North American species of Cactus, Anhalonium and Lophophora. United States Dept. of Agr. 1894). In the former, the areola near the tip of the tubercle does represent the spine-bearing areola, (indeed it contains small spines) and it is not simply the closed upper extremity of the tubercle groove. The true morphology of the groove shows that its upper extremity always is the spine-bearing areola. Comparing the forms *Echinocactus* (*Anhalonium*) *Williamsii* and var. *Lewinii* with *Anhalonium* he concludes naturally that the spine-bearing areolæ and entire upper part of the tubercle are gone. In reality spine-bearing and flower-bearing areolæ were never separated, but remain united as in all *Echinocacti* which lack the groove—as for example *E. horizonthalonius*. Moreover small spines are found in the areolæ, which latter of course also produce the flowers. If one simply imagines these spines to grow out and become large, he has a form exactly comparable with *E. horizonthalonius*—particularly with the young forms of the latter (see Engelmann, Collected Works, plate 32). These species of *Lophophora* therefore are *Echinocacti*.

In the formation of the ribs of the ribbed forms, parts of what would be morphologically surface of the main stem, seem to take part, so that the raised pieces between the successive spine-clusters may be stem and not tubercle in their nature. Where is this true and where not? Only the most careful study, as to whether or not the leaves are laid down in actual contact at the vegetative point, can settle the matter.

[*To be concluded.*]

Smith College, Northampton, Mass.

Flowers and insects. XIV.

CHARLES ROBERTSON.

GENTIANA PUBERULA Michx.—From the abundant observations on European species of *Gentiana* it appears that most of the species which have been investigated are proterandrous, though several are homogamous and a few proterogynous. Most of them are adapted to bumblebees, many to Lepidoptera, while quite a number are intermediate, being visited by both kinds of insects. One species, *G. lutea*, has exposed nectar, and is visited by a miscellaneous list. Nothing has been done with our species, except *G. crinita* and *Andrewsii*.

In the case of *G. Andrewsii*, Beal (6) observed that it was visited by bumblebees, but overlooked the proterandry, supposing that cross-pollination was favored by the stigma standing far above the anthers. A statement of Meehan, that the flower never opens, evidently taking it for granted that it is never visited by insects, is quoted by Henslow (12) in spite of Beal's observations. Vausenburg (10) objects to Beal's conclusions, and supposes that the stigma is pollinated as it passes the anthers. Kunze (18) regards the flower as cleistogamous, the nectar being of no significance. Bailey (17) records that nectar is secreted by the walls of the corolla. Gray (19, 21, 25) states that the flower opens a short time in sunshine, which I have never observed; notes the proterandry and that spontaneous self-pollination may finally occur by the lobes of the stigma curling back until they touch the anthers. Finally I have shown the adaptation to bumblebees and have recorded the abundant visits of *Bombus americanorum* F. ♂♀☿ (41). According to Beal (6) *G. crinita* is visited by bumblebees and resembles *G. Andrewsii*, of which, however, as we have noted, he had failed to recognize the proterandry.

G. Andrewsii and *puberula*, the only species I have found in my neighborhood, are the very latest of the bumblebee flowers, the former beginning to bloom by September 14th, and the latter on the 27th, both running nearly through October.

Gentiana puberula has the stem terminated by a cluster of

handsome bright blue flowers. The corolla measures about 5^{cm}, and the lobes expand horizontally about 3.5^{cm}. The tube is narrowed for about 17^{mm}, the bases of the filaments being attached to the tube for that distance. The free ends of the filaments bend inwards, holding the anthers in a cluster around the style. Bees insert their proboscides between the filaments, and these organs must be 17^{mm} long to exhaust the nectar. The flowers are strongly proterandrous and are adapted to bumblebees. I have seen them visited by *Bombus americanorum* F. ♂☿.

While the flowers of this plant are more conspicuous than those of *G. Andrewsii*, their pollen is not so well protected. Small bees and flies may enter the corollas and remove the pollen without being of any service, but this is prevented in *G. Andrewsii* by the lobes remaining closed.

On the literature of Gentiana see:

(1) Sprengel, Das entdeckte Geheimniss, 150–2. 1793. *G. Pneumonanthe*, proterandry, etc.—(2) Axell, Om anordningarna för de fanerogama växternas befruktning. 1869. *G. Pneumonanthe*, 27, ref. (1). *G. nivalis, lingulata*, homogamous, etc., 101.—(3) Ricca, Osservazioni sulla fecondazione incrociata dei vegetali alpini e subalpini. Atta della Soc. Ital. di Scienze naturale **13**: 254–63. 1870. **14**: 245–64. 1871. *G. acaulis, germanica, verna*.—(4) Kerner, Schutzmittel des Pollens 26, 44. 1873.—(5) Müller, Befruchtung der Blumen 332–3. 1873. *G. Pneumonanthe, Amarella*, pollination.—(6) Beal, The fertilization of gentians by humblebees. Am. Nat. **8**: 180, 226. 1874.—(7) Meehan, Fertilization of Gentiana. Proc. Acad. Nat. Sci. Philad. **1874**: 160. Proterandry, closed fl. seems to make insect pollination difficult.—(8) Delpino, Ulteriori osservazioni, Pt. II. 2: 162, 173, 180. 1875. *G. acaulis, asclepiadea, ciliata, pannonica*, nectar receptacle and guides, proterandry, etc.—(9) Lubbock, British wild flowers in relation to insects, 29, 127. 1875. *G. Pneumonanthe, Amarella*.—(10) Vausenburg, Gentiana Andrewsii. Am. Nat. **9**: 310. 1875.—(11) Kerner, Die Schutzmittel der Blüthen gegen unberufene Gäste. Festschrift Zool.-Bot. Gesellsch. Wien. 1876. Several spp.—(12) Henslow, On the self-fertilization of plants. Trans. Linn. Soc. II. Bot. **1**: 326. 1877. Self-pollination by retention of corolla.—(13) Müller, Alpine species of Gentiana. Nature **15**: 317–19, 473–5. *f. 94–115*. 1877. Several spp.—(14) Müller, Geschichtliche Entwickelung der Gattung *Gentiana*. Kosmos **1**: 162–3. 1877. Abstract of (13)—(15) Müller, Fertilization of flowers by insects. Nature **16**: 265. 1877. *G. Bavarica, verna*, visits of Macroglossa.—(16) Burton, Gentiana asclepiadea and bees. Nature **17**: 201–2. 1877. Perforation.—(17) Bailey, Notes from Rhode Island. Bull. Torr. Bot. Club. **6**: 173. 1877.—(18) Kunze, Cleistogene flowers. ibid. 174. 1877.—(19) Gray, Gentiana Andrewsii. ibid. 179. 1877.—(20) Meehan, Gentiana Andrewsii. ibid. 189. 1877. Stigma receptive after becoming exposed above corolla, etc.—(21) Gray, Note to the review of Darwin's "Forms of Flowers." Am. Jour. Sci. and Arts. III. **15**: 221. Reply to (20).—

(22) Müller, Die Insekten als unbewusste Blumenzüchter. Kosmos **3**: 407, 425, 482. 1878. *G. Bavarica, excisa, lutea, verna.*—(23) Müller, Die Wechselbeziehungen zwischen den Blumen und den ihre Kreuzung vermittelden Insekten. Encycl. der Narturwiss. Breslau **5**: 62. 1879. *G.* subgen. *Cyclostigma*, change from bumblebee to butterfly fls. in Alps.—(24) Bonnier, Les Nectaires. 1879. *G.*, 116, *campestris*, 143.—(25) Gray, Structural Botany 240. 1880.—(26) Müller, Bombus mastrucatus, ein Dysteleolog unter den alpinen Blumensuchern. Kosmos **5**: 422–31. 1880. *G. acaulis, asclepiadea, campestris*, perforation.—(27) Müller, Die Falterblumen des Alpenfrühlings und ihre Liebesboten. Kosmos **6**: 446–56. 1880. *G. verna.*—(28) Thompson, Fertilization of New Zealand flowering plants. Trans. & Proc. New Zeal. Inst. **13**: 241–88. 1880. *G. montana*, proterandrous, etc.—(29) Müller, Die Alpenblumen, ihre Befruchtung durch Insekten, und ihre Anpassungen an dieselben 329–49. 1881. *G. acaulis, asclepiadea, Bavarica, campestris, ciliata, lutea, nana, nivalis, obtusifolia, punctata, tenella, verna*, with notes on others and review of genus.—(30) Müller, Die Entwickelung der Blumenthätigkeit der Insekten. Kosmos **9**: 258–72, 351–70. 1881. *G. acaulis, Bavarica, punctata, verna.*—(31) Müller, Fertilization of flowers, 402–6. 1883. *G. Pneumonanthe, Amarella*, notes on others and review of genus.—(32) Warming, Om Nogle Arktiske Vaexters Biologi. Bihang till K. Svenska Vet.-Acad. Handlingar **12**: 8–12. 1886. *G. nivalis, tenella, Pneumonanthe, involucrata, Amarella, campestris.*—(33) Loew, Weitere Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen des botanischen Gartens zu Berlin. Jahrb. bot. Gartens Berlin **4**: 128–9. 1886. *G.*, Müller on development of.—(34) Huxley, The gentians. Notes and queries. Journ. Linn. Soc. **24**: 101–24. 1887. On the family.—(35) Lindman, Blühen und Bestäubungseinrichtungen im Skandinavischen Hochgebirge. Bot. Centralblatt **30**: 159. 1887. *G. campestris, nivalis*, self-pollination.—(36) Pammel, On the pollination of Phlomis tuberosa and the perforation of flowers. Trans. St. Louis Acad. Sci. **5**: 257–8, 474. 1888. Perforation.—(37) Schulz, Beiträge zur Kenntniss der Bestäubungeinrichtungen und Geschlechtsvertheilung bei den Pflanzen. I. 1888. II. 1890. Bibliotheca Botanica. I. *G. germanica, Amarella, ciliata*, II. *G. acaulis, excisa, verna, campestris, obtusifolia, ciliata*, also 14 spp. perforated by Bombus.—(38) Hansgirg, Ueber d. Verbreitung d. reizbaren Staubfäden u. Narben, sowie d. sich periodisch oder blos einmal öffenden u. schliessenden Blüten. Bot. Centralblatt **43**: 415. 1890. *G. acaulis, Saponaria*, opening and closing of fls.—(39) Kirchner, Beiträge zur Biologie der Blüthen. Progr. z. 72 Jahresfeier d. Kgl. Würtemb. landwirthschaftl. Akademie Hohenheim 47–49. 1890. *G. purpurea, tenella.*—(40) Kerner, Pflanzenleben **2**: 1891. Several spp.—(41) MacLeod, De Pyreneeënbloemen en hare bevruchting door insecten. 1891. *G. verna*, visitors, 343.—(41) Robertson, Flowers and insects. Asclepiadaceæ—Scrophulariaceæ. Trans. St. Louis Acad. Sci. **5**: 577. 1891.—(42) Hansgirg, Neue biologische Mittheilungen. Bot. Centralblatt **52**: 387. 1892. *G. phlogifolia, Fetisowii*, opening and closing of fls.—(43) Hansgirg, Biologische Fragmente. Bot. Centralblatt **56**: 258. 1893. *G. campestris*, opening and closing of fls.—(44) MacLeod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek **5**: 381. 1893. *G. Pneumonanthe.*—(45) Knuth, Blumen und In-

sekten auf den Nordfriesischen Inseln 105. 1894. *G. Pneumonanthe.*—(46) Loew, Blütenbiologische Floristik des mittleren und nördlichen Europa sowie Grönlands. Systematische Zusammenstellung des in den letzten zehn Jahren veröffentlichten Beobachtungsmaterials. 1894. 25 species.

FRASERA CAROLINENSIS Walt.—American columbo.—In the GAZETTE **18:** 48–9, the view was expressed that the hairy crest about the nectaries serves as a foothold, besides concealing the nectar. Its importance as a foothold, however, is not great. It was also supposed that bumblebees might prove to be the principal guests, though they had not been observed about the flowers at that time. In 1894 the flowers were in bloom from May 24th to June 22nd. On May 30th and June 1st, 4th, 8th and 12th the following visitors were noted:

Apidæ: (1) Apis mellifica L. ☿, ab.; (2) Bombus separatus Cr. ☿♀, the most abundant visitor; (3) B. americanorum F. ♀, one; (4) Anthophora abrupta Say ♂♀, freq.

Rhopalocera: (5) Eudamus pylades Scud.—all sucking.

Several species of Andrenidæ, principally *Halictus* and *Augochlora*, visit the flowers for nectar and pollen, but are too small to effect pollination.

PHLOX GLABERRIMA L.—This plant is rather rare. It grows on prairies and was noted in bloom from May 28th to July 30th. The stems grow from 4 to 8^{dm} high, bear handsome corymbs of purple flowers and are often collected in large patches. The border expands about 20^{mm}, and the tube is from 16 to 18^{mm} long. There is a slight appearance of proterandry, but I think that, in case insect visits fail, spontaneous self-pollination may occur by the stigma receiving pollen from the nearest anthers. There is a chance that an insect's proboscis may carry pollen from the long stamens back to the stigma, though the anthers of the long stamens dehisce first. This species agrees with all of the species of *Phlox* which have been observed in being adapted to butterflies. The anthers of the long stamens are so exposed at the mouth of the tube that their pollen is sometimes stolen by syrphids, *Syrphus americanus* Wd., etc. On seven days, between May 28th and July 18th, the following visitors were observed, all sucking:

Lepidoptera—*Rhopalocera:* (1) Danais archippus F.; (2) Colias philodice Gdt.; (3) Papilio thoas L.; (4) P. asterias F.; (5) P. philenor L.; (6) Pamphila peckius Kby.; *Heterocera:* (7) Scepsis fulvicollis Hbn.

PHLOX PILOSA L.—This species is common on prairies, growing in large patches. The flowers are pinkish. The border is about 20^{mm} wide, the tubes 10 to 15^{mm} long. The

style is very short. Self-pollination may be effected by insect aid or may occur spontaneously by the pollen falling in the tube. The frequent visits of insects, however, render cross-pollination inevitable.

The principal visitors are butterflies; but, as commonly occurs with such flowers, long-tongued bees and flies also seek the nectar. The shorter tubes render the nectar more convenient to these insects than in the case of *P. glaberrima*. The plant blooms from May 3d to June 29th. May 8th, 16th, 17th, 31st, and June 5th, the subjoined list was observed, all the insects sucking:—

Lepidoptera—*Rhopalocera:* (1) Phyciodes tharos Dru.; (2) Pyrameis huntera F.; (3) Chrysophanus thoe B.-L.; (4) Colias philodice Gdt.; (5) Papilio asterias F.; (6) Pamphila peckius Kby.; *Heterocera:* (7) Plusia simplex Gn.

Hymenoptera—*Apidæ:* (8) Bombus separatus Cr. ♀; (9) B. pennsylvanicus DeG. ♀; (10) B. americanorum F. ♀; (11) Synhalonia speciosa Cr. ♂♀.

Diptera—*Bombylidæ* (12) Bombylius atriceps Lw.

PHLOX DIVARICATA L.—This is the earliest *Phlox* in my neighborhood, blooming from April 10th to June 2d. I have given a list (14) of eleven species of Lepidoptera and four species of long-tongued bees taken on the flowers. To that list must be added the following:—

Lepidoptera—*Rhopalocera:* (16) Papilio thoas L.; (17) Eudamus tityrus F.; *Heterocera:* (18) Plusia simplex Gn.—all sucking.

On the pollination of Phlox see:

(1) Sprengel, Das entdeckte Geheimniss, 105. 1793. *P. paniculata*, proterandry, butterfly-fl.—(2) Darwin, Forms of Flowers 119-21, 287. 1877. *P. subulata*, doubtful heterostyly.—(3) Bonnier, Les Nectaires 118, 168. 1879. *P. Drummondii.*—(4) Bonnier et Flahault, Observations sur les modifications des végétaux suivant les conditions physiques du milieu. Ann. Sci. Nat. Bot. VI. 8:—1879. *P. Drummondii*, brilliancy of color changing with geographical distribution.—(5) Flahault, Nouvelles observations sur les modifications des végétaux suivant les conditions physiques du milieu. ibid. 9: 159–207. 1880. *P. Drummondii*, colored more lively in Sweden than at Paris.—(6) Francke, Einige Beiträge zur Kenntniss der Bestäubungseinrichtungen der Pflanzen. Inaug. Dessertation. Freiburg-i-B. 1883. *P. setacea.*—(7) Müller, Fertilization of flowers 407. 1883. *P. paniculata*, ref. (1), visitors.—(8) Walker, Insects and Flowers. Nature 28: 388–9. 1883. *P. sp.*—(9) Loew, Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen des Botanischen Gartens zu Berlin. Jahrb. bot. Gartens Berlin **3:** 85 (17). 1884, *P. reptans*, *subulata*, visits of Apis.—(10) Loew, Weitere Beobachtungen, etc. ibid. **4:** 153, 1886. *P. paniculata*, visit of Echinomyia.—(11) MacLeod, Untersuch-

ungen über der Befruchtung der Blumen. Bot. Centralblatt 29: 119. 1887. *P. sp.*, visit of Plusia.—(12) Kerner, Pflanzenleben. 2: 111, 1891. Protection of pollen.—(13) Peter, Polemoniaceæ, Engler und Prantl, Die nat. Pflanzenfamilien 68: 40–48. 1891. Pollination.—(14) Robertson, Flowers and Insects. Asclepiadaceæ–Scrophulariaceæ, Trans. St. Louis Acad. Sci. 5: 578. 1891.—(15) Knuth, Blütenbiologische Herbstbeobachtungen. Bot. Centralblatt 49: 363. 1892. *P. acuminata*, vis. three butterflies.

LITHOSPERMUM CANESCENS (MX.) Lehm.—According to Müller (4, 12, 13), *L. arvense* is homogamous and regularly self-pol-linated, though there is a chance of cross-pollination when the flower first opens. According to Kerner (18 Loew 21) it is slightly proterogynous, but Müller says the anthers begin to discharge their pollen before the flower opens. *L. purpureo-coeruleum* is slightly proterogynous, with anthers and stigma of equal height (17). *L. arvense* has small white flowers, rarely with blue (Loew 21) with tubes 4–5^{mm} long. Sprengel (1) saw it visited by butterflies, and Müller (4, 12, 13) observed as visitors two butterflies, two bees and two syrphids. *L. purpureo-coeruleum*, with red flowers changing to blue (17) and tubes 8–9^{mm} long (21), and *L. officinale* with small, dull white flowers, are classed by Loew (14) as bee-flowers. In the Berlin Garden the former is visited by *Anthophora pilipes* and *Osmia aenea*, and the latter by *Megachile willughbiella*.

Bebb (5) discovered that *L. longiflorum* is only the early state of *L. angustifolium*. This and *L. canescens* are early species which are able to attract insects until about the first of June (10), when probably on account of being over-shadowed by the trees or by the later more luxuriant vegetation, the latter goes out of bloom and the former continues to produce cleistogamic flowers. Bessey (10) concludes that *L. angustifolium* is not dimorphous, but highly variable, and Halsted (16) comes to about the same conclusion. In the case of *L. canescens*, Smith (9) seems to have regarded the flower as dimorphous, but found a rare third form with "flowers differing from the ordinary dimorphous condition." Bessey (10) regards it as a case of well marked dimorphism, though according to Darwin (11) the forms are variable and the case requires further investigation. Christy (15) mentions only two forms. Halsted (16) calls it decidedly dimorphic, saying he has seen no indication of trimorphism. At Madison, Wisconsin, Trelease (MS. notes) found only two forms and regarded

the species as truly dimorphic. I have not taken great pains to examine flowers, but in all cases examined I have found indication of nothing but dimorphism.

In my neighborhood, *Lithospermum canescens* is the earliest butterfly-flower, blooming from March 18th to June 12th. The stems, often several from the same base, rise from 1 to 3^{dm}. The racemes as they uncoil expose two or three erect orange-yellow flowers. The corolla is salver-form. The five-lobed border expands about 15^{mm}. The tube is about 8^{mm} long. At the throat it is narrowed to a diameter of about 1^{mm} by appendages whose purpose seems to be to restrict the visitors to slender tongues. The orange-yellow color and the narrow tube indicate an adaptation to butterflies, but the flowers are also visited by long-tongued bees. On April 30th, May 1st, 2nd, 17th, 20th, and June 5th the visitors observed were:

Lepidoptera—*Rhopalocera:* (1), Pyrameis huntera F.; (2) Chrysophanus thoe B.-L.; (3) Colias philodice Gdt., very ab.; (4) Papilio ajax L'; (5) P. asterias F.; (6) Nisoniades icelus Lint.

Hymenoptera—*Apidæ:* (7) Bombus americanorum F. ♀, ab.; (8) Synhalonia speciosa Cr. ♂ ♀, ab.; (9) Osmia cobaltina Cr. ♀, one.

Diptera—*Bombylidæ:* (10) Bombylius major L.—all sucking.

On the pollination of *Lithospermum* see:

(1) Sprengel, Das entdeckte Geheimniss 88. 1793.—(2) Kuhn, Einige Bemerkungen über Vandellia und den Blüthenpolymorphismus. Bot. Zeit. 25: 67. 1867. *L.*, heterostyled dimorphism in.—(3) Axell, Om anordningarna för de fanerogama växternas befruktning 22, 99. 1869. Ref. (2).—(4) Müller, Befruchtung der Blumen 270. 1873.—(5) Bebb, Lithospermum longiflorum only L. angustifolium. Am. Nat. 7: 691. 1873.—(6) Lubbock, British Wild Flowers in Relation to Insects 132. 1875. *L. arvense*, ref. (4)—(7) Henslow, On the self-fertilization of plants 375. 1877. *L. arvense*, ref. (6)—(8) Bonnier, Les Nectaires 125, 1879. *L. arvense.*—(9) Smith, Trimorphism in Lithospermum canescens. Bot. Gaz. 4: 168. 1879.—(10) Bessey, The supposed dimorphism of Lithospermum longiflorum (L. angustifolium). Am. Nat. 14: 417–21. 1880.—(11) Darwin, Forms of flowers. 2nd edit. 1880. *L. canescens* and *longiflorum*, ref. (9) and (10).—(12) Müller, Weitere Beobachtungen 3: 16. 1882.—(13) Müller, Fertilization of Flowers 417–18. 1883. *L. arvense*, pollination. *L. canescens*, *longiflorum*, ref. (11)—(14) Loew, Beobachtungen über den Blumenbesuch von Insekten an Freilandpflanzen des Botanischen Gartens zu Berlin. 1884. *L. arvense*, 8. *L. purpureo-coeruleum*, 38, 49, *L. officinale*, 45.—(15) Christy, Heterostyled plants. Journ of Bot. 23: 49–50, 1885. *L. canescens*, *hirsutum*, relative abundance of long and short-styled fls.—(16) Halsted, Notes upon Lithospermum. Bot. Gaz. 14: 202–3. 1889.—(17) Kirchner, Beiträge zur Biologie der Bluthen. Progr. z. 72 Jahresfeier d. K. Würtemb. landwirthschaftl. Akademie Hohenheim 51. 1890.—(18)

Kerner, Pflanzenleben. **2**: 1891. *L. purpureo-coeruleum*, color change, 190. *L. arvense*, autogamy, etc., 309, 330.—(19) Loew, Blüthenbiologische Beiträge II. Pringsheim's Jahrbücher, **23**: 52–3. 1892. *L. purpureo-coeruleum.*—(20) Mac Leod, Over de bevruchting der bloemen in het Kempisch gedeelte van Vlaanderen. Bot. Jaarboek **5**: 335. 1893. *L. arvense.*—(21) Loew, Blütenbiologische Floristik 282. 1894. *L. arvense, purpureo-coeruleum.*

PHYSALIS LANCEOLATA Michx.—According to Kirchner (2) *P. alkekengi* is proterogynous. The anthers finally approach the stigma until autogamy may occur. Kerner (3) states that autogamy results from the lengthening of the corolla.

Physalis lanceolata is common. The stem rises 3^{dm} or more and bears numerous pendulous flowers, which expand about 20^{mm}. The flowers are yellowish, the centers usually marked with five dark purple spots. The nectar is lodged in grooves alternating with the filaments, each groove being bounded on each side by a line of dense hairs. To reach the nectar, bees thrust their proboscides between the bases of the filaments. The broad bases of the filaments with the alternating tufts of hair nearly close the tube. The tufts aid in concealing the nectar and probably aid the bees in clinging to the pendulous flower.

The anthers dehisce in succession, so that to collect all of the pollen, the bees must visit each flower several times. Cross-pollination results from the stigma being in advance of the anthers and being touched before them. There may be slight proterogyny and in absence of insects autogamy may occur as in *P. alkekengi*. *P. lanceolata* blooms from May 12th to Sept. 21st. It is visited regularly and abundantly by (1) *Colletes latitarsis* Rob. ♂♀, s. and c. p., July 6th, Aug. 7th, Sept. 5th, 21st; (2) *C. willistonii* Rob. ♂♀, s. and c. p. May 29th, June 7th, 11th, Sept. 5th.

PHYSALIS VIRGINIANA Mill.—This species resembles the preceding. It blooms from June 7th to Oct. 4th and is visited for nectar and pollen by *Colletes latitarsis* Rob. ♂♀, ab., July 6th, 9th, 22nd, 25th, 26th, and *Halictus pectinatus* Rob. ♀, c. p., two, June 25th.

PHYSALIS PHILADELPHICA Lam.—This also agrees with *P. lanceolata* in most essential particulars. It was noted in bloom from July 12th to Sept. 27th. The flowers are visited for pollen by *Colletes latitarsis* Rob. ♀, July 27th.

The species of *Physalis* occurring in my neighborhood are

remarkable for their close mutual relation with two bees of the genus *Colletes*. As far as known, *Heuchera hispida*[7] is the only other flower adapted to a bee of this genus. On twelve days, between May 29th and Sept. 21st, I found the flowers to be visited by these bees and by no other insects, except the *Halictus* taken on *P. Virginiana*.

I have taken single females of *Colletes latitarsis* on flowers of *Asclepias incarnata* (entrapped and dead) and *Polygonum hydropiperoides*. Both sexes are abundant on *Physalis*, and the female seems to depend exclusively upon the pollen of these flowers.

I have taken *Colletes willistonii* on flowers of *Rhus glabra* and *Melilotus alba*, but have never seen it collecting any pollen except of *Physalis*.

On the pollination of Physalis see:
(1) Sprengel, Das entdeckte Geheimniss 127–8. 1793. *P. alkekengi, pubescens*, nectar-glands, guides, etc.—(2) Kirchner, Neue Beobachtungen über die Bestäubungseinrichtungen einheimischer Pflanzen, Progr. d. 68 Jahresfeier d. K. Würtemb. landwirtsch. Akademie Hohenheim. 1886.—(3) Kerner, Pflanzenleben. **2**: 1891. Protection of pollen, 118, "revolverblüthen," 250, autogamy, 361.—(4) Wettstein, Solanaceæ. Engler u. Prantl, die nat. Pflanzenfamilien 65: 8. 1891. *P.*, pollination of.—(5) Loew, Blütenbiologische Floristik 285. 1894. *P. alkekengi*, ref. (2 and 3).

MIMULUS RINGENS L.—The flowers of *Mimulus* are homogamous. Bees entering the corolla first touch the stigma, which closes up and exposes the anthers behind it. Self-pollination occurs in *M. luteus*, but Darwin (13) found that pollen from another plant was prepotent over the flower's own pollen. He saw *M. roseus* visited by bees. According to Batalin (6) *M. guttatus* is visited by bees.

The irritability of the stigma of *Mimulus* was well known to Kurt Sprengel (1), Braconnot (2) and Vaucher (3). The latter mentions it as occurring in *M. luteus* and *glutinosus*, and supposes that it occurs in other members of the genus. This has been verified to such an extent that now it seems that a *Mimulus* without an irritable stigma would be a desideratum. Delpino (4, 7) was first to indicate the advantage of the movement in facilitating cross-pollination.

In the case of *Mimulus ringens*, Meehan (17) states that the stamens dehisce and the stigmas generally show pollen before the flowers are quite open. He observes the movement of

[7] Bot. Gaz. **17**: 178. 1892.

the stigma, and is the only one who does not regard it of any advantage. According to Beal (18) a student, Penoyer, has proved by detailed experiment that the flower is not self-pollinating. Foerste (25) observes that cross-pollination is not insured, and that the tubes are too long for the smaller bees.

The flowers are violet purple, the yellow palate forming a path-finder. The stigma slightly exceeds the anthers. I have found the lower lobe of the stigma with its tip touching the pollen. But most of the stigmatic surface remains exposed and may be thoroughly dusted with pollen from another flower. The corolla tube measures about 19^{mm}, but bees can insert their heads for about 5^{mm}, so that a tongue 14^{mm} long can exhaust the nectar. The plants are frequent in wet places, the stems growing from 11 to 14^{dm} high. The flowers were observed in bloom from July 11th to September 7th. They are visited for nectar by *Bombus americanorum* F. ♀.

MIMULUS ALATUS Soland.—See Foerste (25).—This flower is also adapted to bumblebees. It resembles the preceding, but the palate is larger, paler, and more strongly bearded. The tube measures 18^{mm} long. Bees can insert their heads for about 7^{mm} and drain the tube with a proboscis 11^{mm} long. As in *M. ringens*, the stigma finally touches the pollen and may be self-pollinated, but I am inclined to believe that the flowers are seldom neglected for a whole day, and are regularly cross-pollinated by bumblebees. The plants are not so tall as in *M. ringens*. They bloom from July 13th to Sept. 7th. The flower is visited for nectar by *Bombus americanorum* F. ♀.

On the pollination of Mimulus see:

(1) Sprengel, Anleitung zur Kenntniss der Gewächse **1**: 192, 274. 1817.—(2) Braconnot, Sur l'irritabilité du stigmate des Mimulus. Ann. de Chim. et de Phys. **29**: 333–4. 1825.—(3) Vaucher, Histoire physiologique des Plantes d' Europe **3**: 525. 1841.—(4) Delpino, Sugli apparecchi della fecondazione nelle piante antocarpee 32. 1867.—(5) Hildebrand, Federigo Delpino's Beobachtungen über die Bestäubungseinrichtungen bei den Pflanzen. Bot. Zeit. **25**: 284. 1867. *M. glutinosus* (*Diplacus puniceus* Nutt.), irritable stigma.—(6) Batalin, Beobachtungen über die Bestäubung einiger Pflanzen. Bot. Zeit. **28**: 53–4. 1870. Sensitive stigma, etc.—(7) Delpino, Ulteriori osservazioni. II. 2: 151. 1873.—(8) Müller, Befruchtung der Blumen 283. 1873.—(9) Kitchener, On cross-fertilization as aided by sensitive motion in musk and Achimenes. Jour. of Bot. **2**: 101–3. Am. Nat. **7**: 478–80. 1873. *M. moschatus.*—(10) Kitchener, A Year's Botany 118. 1874. Significance of sensitive stigma. Cit. by Darwin (13).—(11) Heckel, Du mouvement dans les stigmates bilobiés des Scrophularinées, des Bignoniacées et des Sésamées. Comptes Rendus **79**: 702–4. 1874. Cit. by

Miyoshi (28).—(12) Heckel, Sur la motilite dans quelques organes reproducteurs des Phanerogames. Thèse pour le doctorat ès sci. naturelles. 1875.—(13) Darwin, Cross and self-fertilization of plants. 1876. *M. roseus*, irritable stigma and visitors, 63. *M. luteus*, extended observations.—(14) Henslow, On the self-fertilization of plants. Trans. Linn. Soc. II. **1**:—1877. *M. luteus*, review of Darwin's observations.—(15) Behrens, Beiträge zur Geschichte der Bestäubungstheorie. Progr. d. Kgl. Gewerbschule zu Elberfeld 24–5. 1877–8. *M. luteus* (*Tilingii*), sensitive stigma, homogamy, etc.—(16) Heckel, Des relations que presentent les phénomènes propres aux organes reproducteurs de quelques Phanérogames avec la fécondation croisée et la fécondation directe. Comptes Rendus **87**: 697–700. 1878. Sensitive stigmas and pollination.—(17) Meehan, Irritable or sensitive stamens. Proc. Acad. Sci. Phila. **1878**: 333.—(18) Beal, The agency of insects in fertilization. Am. Nat. **14**: 202. 1880.—(19) Behrens, Blumen und Insekten. Methodisches Lehrbuch der Botanik für hohere Lehranstalten. 1880. *M. luteus* (*Tilingii*).—(20) Thompson, Fertilization of New Zealand flowering plants. Trans. New Zeal. Institute **13**: 241–88. 1880. *M. luteus*.—(21) Meehan, The stigma of Catalpa. Bot. Gaz. **8**: 191. 1883. Stigma of common garden *M.* closes in fifteen seconds.—(22) Müller, Fertilization of Flowers 436. 1883. *M. luteus* (*guttatus*, *Tilingii*), *puniceus*, ref. (5, 6, 15)—(23) Hoffmann, Culturversuche über Variation. Bot. Zeit. **42**: 216. 1884. *M. cardinalis* × *moschatus*, fruitful.—(24) Oliver, Ueber Fortleitung des Reizes bei reizbaren Narben. Ber. deut. bot. Gesellsch. **5**: 162–9. 1887. *M. luteus*, *cardinalis*.—(25) Foerste, Notes on structures adapted to cross-fertilization. Bot. Gaz. **13**: 153. 1888. *M. alatus*, *ringens*.—(26) Hansgirg, Ueber die Verbreitung der reizbaren Staubfäden und Narben, etc. Bot. Centralblatt **43**: 413. 1890. *M. ringens*, *purpureus*, *Lewissii*, *Californicus*, *parviflorus*, *moschatus*, *cardinalis*, *luteus*, (*Roezlii*, *cupreus*, *guttatus*, *Tilingii*).—(27) Kerner, Pflanzenleben **2**: 127, 253, 280. *M. luteus*.—(28) Miyoshi, Notes on the irritability of the stigma. Journ. of Sci. Imp. Univ. Tokio **1891**: 211. *M. Nepalensis*, *sessilifolius*, *moschatus*.—(29) Wettstein, Scrophulariaceæ. Engler und Prantl, Die nat. Pflanzenfamilien 65: 46–7. 1891. Pollination.

Carlinville, Illinois.

Notes from my herbarium. II.

WALTER DEANE.

NYMPHAEA ODORATA Ait. Sweet-scented water-lily.

The sweet-scented water-lily, whose chief attraction to the lover of nature is its beautiful flower, grows throughout eastern North America, and its praises have long been sung in prose and poetry. To the close observer, however, the flower is but one of many points of interest, and I have taken the greatest pleasure in collecting the plant for my herbarium. Even the best of professional collectors rarely send out in their sets full representations of the immersed parts of this plant. Indeed, it would not be a paying business if they did, for it took me the greater part of an afternoon to prepare satisfactory specimens for my own herbarium.

I spent a portion of July, 1886, in the Old Manse, in Concord, Mass., on the banks of the Concord river, close by the old battle-field. In early July, for some miles on either side of the stream, the water-lilies form a continuous bed of snowy white. I had already collected, elsewhere, the flowers and leaves, not realizing at the time what a small portion of the plant my herbarium would show. I resolved, now, to represent the whole plant, and, so, one pleasant afternoon, I took a boat and a rake, and rowed to a spot where the flowers were not too thick, and the water was about three feet deep. Then, getting the tines of the rake under a thick rootstock, I drew up a complete plant. I made a longitudinal section of the rootstock, keeping about a foot of it in length, and leaving the large terminal bud in place. The consistency of the stock is about that of a green apple. I trimmed the specimen carefully, leaving enough to show all the features, a single flower, a fully-developed leaf, of which I bent over a small portion to show the under surface, and three unopened leaves, which had not reached the surface. The vernation of the leaves is involute, and before expansion they resemble exactly those of *Sagittaria latifolia* Willd. form *c*, of J. G. Smith's recent revision. The smallest of these leaves is but an inch long, with a stem two inches long. This leaf had barely emerged from the mud at the river bottom. I left some of the copious roots on the stock, and by coiling the peduncle, petiole

and roots, I made a good herbarium specimen. It took the rootstock some weeks to dry. It flattened gradually in the press, and is now three-sixteenths of an inch thick. It represents the original as well as a herbarium specimen can.

To illustrate the roots more fully, I made a specimen of rootstock and roots only, with the exception of an immersed leaf. The roots are about one-eighth of an inch wide at the base, and taper gradually. They are clothed with fine hairs, and average two feet in length. The immersed leaf was on a petiole five and one-half inches long, and, so, was nearly three feet under water. It was fully developed, dark brown on both sides, and generally round in outline, but with a very broad sinus, differing in this respect very much from the floating leaves.

Not the least interesting part of the plant is the fruit, while the manner of fruiting shows a wonderful adaptation of means to an end. The peculiar coiling of the stem, and the consequent drawing of the flower under water is an old story to tell, but the search and discovery of the fruit is ever a fresh one, for it is not always easy to find. On October 9, 1886, I was again in Concord, visiting the late Mr. Edw. S. Hoar, a good botanist, and an old friend of Henry D. Thoreau, with whom every spot in Concord is identified. We rowed on the river in search of the fruit of the water-lily. The air was still, the water perfectly clear for several feet in depth, and, as we moved slowly along over the places where in July the surface of the stream was white with the blossoms, I gazed down into the water searching for fruit. It is very strange what had become of the thousands of flowers. I found only two good fruits, and one almost eaten up by some water robber. Perhaps this last fact will partly explain their scarcity.

The fruits were from one to two feet under water, and one must know what to look for or he will certainly not be successful, even if the fruit is plentiful. The sepals and petals are still *in situ*, and the appearance is exactly that of a bud, for the pressure of the water keeps the sepals closed tight. The season of the year will determine whether it is a bud or fruit. The petals do not drop off, but slowly macerate. I found the fruit more easily in 1888, in Grassy Pond, Acton, Mass., but it was by no means abundant, although I know it is sometimes easily found.

If the surface of the water is ruffled, or the water itself is turbid, it can readily be seen how difficult the securing of the fruit must be. The stem coils in the middle or lower half

and part of the coils are to the right, and part to the left. The coils are about one inch in width, and in my specimens they vary from five to nine in number. The fruit varies in size from about an inch to three-quarters of an inch in diameter. One must be sure to put into a pocket on the sheet cross-sections of the rootstock and of the fruit. The latter will show the seeds with their sac-like aril covering, and their peculiar habit of lining the inner face of the carpels, instead of growing on a distinct placenta.

These furnishings to a herbarium show the wonderful apparatus needed to produce the delicate flower of the water-lily.

APOCYNUM ANDROSAEMIFOLIUM L. Spreading dogbane.

I have a peculiar case of teratology in this plant. Two leaves have grown into one. They have a common base, and the appearance is the same as if the leaves had lapped over on to each other for about three quarters of an inch. There are two midribs, which are about half an inch apart in the middle of the leaf, and each leaf has its own separate apex, the two points being three-eighths of an inch apart. The venation between the midribs is normal, except that the primary veins are not nearly so spreading as those on the other side of the midribs. They curve quickly and are almost parallel to the midrib, as if crowded, as they really are. It is hard to believe that there are not two separate leaves before one, partly overlapping. I collected the specimen June 16, 1894, in Weston, Mass.

TYPHA LATIFOLIA L. Common cat-tail flag.

To represent completely our common cat-tail flag, the plant must be visited early in the season, before the enveloping spathes or bracts have opened. My herbarium sheets show these early forms, and aid me in the following sketch. I visited a swamp in Cambridge, Mass., on June 26th, and found the plant in prime condition. I first secured a specimen, in which the inflorescence was completely invisible. One spathe enwrapped the staminate spike above. It was firmly attached at the base, and terminated in a leafy projection five inches long. Another spathe enclosed the pistillate spike, and the greater part of the staminate spike, and had a leafy projection just a foot long, overtopping the staminate spike by five and one-half inches. These leafy

terminations of the spathes resemble so closely the true leaves that I looked about for some time before I could discover the hidden inflorescence. I suppose that, had I visited the plant earlier still, the staminate spike, bract and all, would have been entirely enclosed by the female spathe.

Another plant showed the inflorescence a little farther advanced. The pistillate flowers were entirely free from the spathe which was but lightly attached to the base of the spike. I pressed it separately, for it became detached as I gathered the plant, and I have mounted it on the sheet near its original position, labelling it as belonging to the base of the female spike. The enveloping part of the spathe is three-quarters of an inch wide, and is light brown, as when I collected it, while the long leafy projection is a deep green, exactly resembling the color of the leaves. The male spike was just freeing itself from its spathe, and was shedding its pollen in copious showers. At intervals along the inflorescence, small bracts projected. On examining my various specimens, I find that the greatest number of bracts is six, varying in length from one-half to six inches. In one case a bract, half way up the spike, encloses the top of the spike, just as the bract or spathe at the base encloses the whole spike. The leaves of the plant have broad, sheathing bases, and there is a beautiful gradation from leaf to smallest bract. One can hardly afford to omit this feature from his herbarium. I pressed specimens showing every possible stage of inflorescence.

The fruit, though bulky, can easily be managed later in the season. A good way to supplement a specimen of the entire fruiting spike is to section one longitudinally, and mount it so as to show the inner face, with the stipitate fruit intact. The dark outer surface is then shown to be composed of the stigmatic surfaces on the ends of innumerable styles, while within are the copious hairs growing on the stipes. No dissection will be necessary to show this.

On August 14, 1886, at Rye Beach, N. H., I took up a whole plant to show the creeping rootstocks and the fibrous roots. My specimen has four stocks, the longest being one foot and two inches. The scaly nodes are about an inch and a half apart, and throw out but few roots. The stocks are about half an inch thick and, when fresh, were very white. The plant roots very freely from its base, the roots being

long, with coarse fringing hairs half an inch in length. To show the roots and rootstocks fully, the upper part of the plant must be sacrificed or mounted on another sheet. I do not believe in folding a plant so that parts will overlap and crowd too much, thereby sacrificing clearness of detail, just to bring the whole plant within the limits of a mounting sheet. Herbarium specimens, too often, exhibit two extremes of careless work. They are either too fragmentary or too crowded. The utmost endeavors should be used to make the best specimens possible, that our herbaria may be visited for their aesthetic as well as useful qualities.

Cambridge, Mass.

Synopsis of North American Amaranthaceæ. II.[1]

EDWIN B. ULINE AND WILLIAM L. BRAY.

ACNIDA L. Sp. Pl. 1027. 1753.

Flowers completely diœcious, the pistillate ones without calyx, the staminate ones with 5 equal oblong sepals and 5 stamens: otherwise like *Amaranthus*.

At the time of the publication of Linnæus' *Species Plantarum*, but a single species of this genus was described, namely, *A. cannabina*. The specimen was collected in Virginia and was described in 1741 by Dr. John Mitchell under the generic name *Acnide*. Dr. Gray in his revision of the genus[2] states that "on the whole our botanists have failed to make out more than one species," although Moquin-Tandon had already described *A. rusocarpa*. Dr. Gray set up three sections: (1) EUACNIDA, in which he sets apart *A. rhyssocarpa* (*A. rusocarpa* Moq.) and adds *A. australis* (*A. cannabina* Chap.); (2) MONTELIA Moq., characterized by its indehiscent utricles, including *A. tuberculata;* (3) PYXIDI-MONTELIA, including *A. tamariscina* (*Amarantus tamariscinus* Nutt. and *Montelia tamariscina* Gray, in part).

With the increasing knowledge of the geographical distribution of the species, and with the considerable additions to herbarium material since Dr. Gray's revision, most of which we have seen, it seems best to indicate a somewhat modified disposition of the species. On the basis of geographical distribution, two very natural groups present themselves, those of the salt marsh and coast region of the Atlantic, and the inland and western forms. The former embraces Gray's EUACNIDA and *A. Floridana* Watson. Of the three species referred by him to this section, we believe that *A. cannabina* and *A. rusocarpa* are not distinct. We find here a complete series of intergradations, while the difference of age actually accounts for more than the difference called for in their original delimitation. The third species of EUACNIDA, *A. australis*, shows no specific departure from the others, but its range is

[1] The first number of this series, presenting the genus *Amaranthus*, was published in BOT. GAZ. **19:** 267, 313. 1894.

[2] Am. Nat. **9:** 487. 1876.

somewhat different, occurring mostly in Florida. This, in view of its comparatively slight variation from the species has prompted us to reduce it to a variety. *A. Floridana* stands as a distinct species. Of the inland and western forms there seems to be but one polymorphous species, consisting chiefly of tall erect plants with small indehiscent utricles (*A. tamariscina tuberculata* Moq.), although the original form of the group is characterized principally by a dehiscent utricle. According to priority these inland forms become *A. tamariscina.*

Finally, there is the definite shading toward *Amaranthus*, which is seen in certain specimens, which seem to defy all attempts at classification. This tendency is seen mostly in the appearance of minute sepals, varying in number. As this is the principal difference between *Acnida* and *Amaranthus*, it would seem that the generic rank of *Acnida* is not yet finally established.

SYNOPSIS OF THE SPECIES.

Fruit angled (Atlantic coast).
  Utricle fleshy, turning black.
    1^{mm} long or less . . . . . *A. cannabina australis.*
    2 to 4^{mm} long, ... *A. cannabina.*
    Utricle thin and small . . . . *A. Floridana.*
Fruit not angled, 1^{mm} long (interior).
  Utricle indehiscent.
    Plant erect, inflorescence spicate, *A. tamariscina tuberculata.*
    Plant erect, spikes glomerulate, *A. tamariscina concatenata.*
    Plant prostrate . . . . . *A. tamariscina prostrata.*
    Utricle circumscissile . . . *A. tamariscina.*

1. A. CANNABINA L. Sp. Pl. 1027. 1753.

A. rusocarpa Mx. Fl. Bor.-Am. 2: 234. pl. 50. 1803.
A. salicifolia Raf. Am. Month. Mag. 2: 43. 1817.
A. obtusifolia Raf. (and vars.) New Fl. N. Am. 1: 53–55. 1836.
A. cannabina salicifolia Moq. DC. Prodr. 13^{2}: 278. 1849.

Tall, with leaves long, lanceolate, tapering at both ends: inflorescence naked and slender: bracts short: utricle mostly smooth, but sometimes rugose on the angles, orbicular, turning black in maturity: stigmas spreading: staminate flowers large, characterized by the oblong obtuse scarcely mucronate sepals.—River-banks and salt marshes in the Atlantic Coast Region from New England to South Carolina. Type unknown.

A. CANNABINA AUSTRALIS (Gray).

A. australis Gray (in part), Am. Nat. 10: 489. 1876.

Plant and leaves larger: bracts various, sometimes almost as long as the flower: utricle ovate, smaller than in the species: stigmas divaricate: spikes naked, long, slender and paniculate.—Alabama, Florida, West Indies and Mexico. Gray's types in herb. Gray, Columbia College and J. D. Smith. This variety is intended to embrace all southeastern forms having the above characters, which will give it a somewhat wider scope than the *A. australis* Gray.

2. A. FLORIDANA Wats. Proc. Am. Acad. **10:** 376. 1882.

Tall and slender, leaves linear to narrowly lanceolate, obtuse, attenuate to a slender petiole: flowers scattered on very slender, strict, elongated spikes: utricle faintly angled, tuberculate: staminate flowers more crowded.—Chiefly in Southern Florida. Types in herb. Gray, Columbia College, J. D. Smith and National herb.

3. A. TAMARISCINA (Nutt.) Wood, Bot. 289 (1874).

Amarantus tamariscinus Nutt. Trans. Phil. Soc. N. S. 5: 165. 1837.

This species possesses in some respects the habit of *Amaranthus græcizans*, having in common with that species slender and acuminate spikes, spinulose bracts and sepals, and a circumscissile utricle.—Indigenous on the dry prairies of the west and southwest, extending northward to Dakota, and occasionally found as far east as Illinois. The staminate forms are not easily distinguished from those of *Amaranthus Torreyi*, whose range overlaps that of this species on the west. The only specimen of Nuttall's type seen by us is a fragment in herb. Columbia College collected by Nuttall in Indian Territory, and labelled "Salt Creek." The specimen is very immature, but the locality, the slender acuminate spikes, and the spinulose bracts enable us to determine its place with reasonable certainty.

A. TAMARISCINA TUBERCULATA (Moq.).

A. tuberculata Moq. DC. Prodr. 13^2: 278. 1849.
A. rusocarpa Moq. l. c.
A. tuberculata subnuda Watson (in part) Gray Man. 429. 1889. [ed. 6.]
A. tamariscina subnuda Coult. (in part) Mem. Torr. Bot. Club 5: 145. 1894.

Rank tall weed with flexuous branches similar in habit to *Amaranthus hybridus*, having an ovate, tuberculate, indehis-

cent utricle. The spreading bracts and withering stigmas render the utricles somewhat conspicuous when old. This probably accounts for one of the characters on which Dr. Watson based his var. *subnuda*. Those forms of Watson's var. *subnuda* with clustered inflorescence belong naturally with the following variety.—Most abundant in the north central states east and west of the Mississippi, but extending as far as Manitoba at the north, Vermont at the east, Tennessee at the south and western Nebraska at the west. With the exception of ballast specimens from New Jersey no Atlantic coast specimens were seen.

A. TAMARISCINA CONCATENATA (Moq.).

A. cannabina concatenata Moq. DC. Prodr. **13**[2]: 278. 1849.
Montelia tamariscina concatenata Gray Man. 413. 1868. [ed. 5].
A. tuberculata subnuda Wats. (in part) l. c.
A. tamariscina subnuda Coulter (in part) l. c.

Somewhat weaker, often decumbent, with rather large flowers in isolated glomerules. Though there are occasional transition forms between this and the above, the mass of them seems to form a natural group, which may very conveniently be set apart.—Range as in the above variety. The locality and the aggregate inflorescence point to the probable identity of this with Moquin-Tandon's variety, though in one specimen of *Acnida cannabina*, collected in Massachusetts, the same aggregated tendency was seen.

A. TAMARISCINA **prostrata,** var. nov.

Prostrate and diffusely spreading after the manner of *Amaranthus crispus*, though sometimes ascending as in *Amaranthus deflexus:* leaves small, spatulate: inflorescence crowded in axillary clusters and sometimes in minute glomerules, leafy. —Michigan to Dakota, extending as far south as Missouri. Type specimens in Nat. herb. and Mo. Bot. Gard.

GOMPHRENA L. Sp. Pl. 224. 1753.

Hirsute or villous herbs, erect, decumbent or prostrate, with usually swollen nodes, sessile or short petioled entire leaves, mostly solitary but sometimes clustered heads, which are usually sessile, though sometimes peduncled, perfect flowers, 5-parted calyx often villous at base, and stamen tube 5-cleft with emarginate or 2-cleft lobes, ovules with long strap-shaped funiculus.

**Stigmas short, stout, nearly sessile: bractlets keeled and slightly crested.*

1. G. NEALLEYI Coult. & Fish. Bot. Gaz. **17:** 349. 1892.

Ascending from a fusiform root, having the habit of *G. decumbens* but easily distinguished by its subsessile stigmas, sepals indurated and more or less united at base.—In addition to the type, which was collected at Corpus Christi by Nealley in 1889, two specimens have been seen: Texas on the Lower Rio Grande (*Schott* 1853 of Mex. Bound. Surv.); Mexico (*Ervenberg* 140 in 1858). Type in herb. J. M. Coulter and Nat. herb.

** *Stigmas filiform on a long style: bractlets keeled, more or less crested.*

÷ *Heads and flowers small.*

2. G. PRINGLEI Coult. & Fish. Bot. Gaz. **17:** 349. 1892.

Plant prostrate, many-stemmed from a long filiform root: stems rose-colored, very slender, dichotomously or trichotomously branched: bractlets broadly and laciniately crested: flowers very small.—Mexico. Type in herb. J. M. Coulter, with corresponding collection numbers in herb. Columbia College and J. D. Smith.

3. G. DECUMBENS Jacq. Hort. Schoenbr. *pl. 482.*

G. prostrata Desf. Hort. Par. app. 219. 1804, non Mart.

Stem procumbent (sometimes nearly erect), much branched, mostly dull gray or brownish in color: heads globose to globose-cylindrical according to age, dirty white or sometimes roseate: bractlets obtuse, keeled and crested, scarcely longer than the obtuse sepals.—Texas, West Indies and Mexico. Type unknown.

4. G. NITIDA Rothr. Wheeler's Rep. Bot. Geogr. Surv. **6:** 233. 1878.

G. globosa albiflora Moq. DC. Prodr. 13²: 409. 1849.

Nearest in habit and appearance to *G. decumbens*, but mostly erect (sometimes procumbent), and rather stouter, with heads rather larger and mostly more globular, pearly white or rose-colored, flowers larger with long sharp bractlets and sepals, the former crested and sharply laciniate, one-third longer than the sepals.—Southern Arizona and nothern Mexico. Rothrock's specimen no. 520, collected in the Chirricahua Mts., Arizona, in 1874, is in the National herbarium. Moquin's

type is unknown. The original name of Moquin's variety is not retained because of its previous adoption in this genus as a specific name.

A further acquaintance with growing specimens of *G. decumbens* and *G. nitida* may lead to their consolidation, for it is difficult to distinguish them on the basis of general habit. Rothrock, however, says of *G. nitida*, "Certainly it is not *G. decumbens* Jacq., as in the latter only the interior sepals are silky, and the outer ones are obtuse, whereas in my specimens all are silky and acute."

+ + *Heads and flowers large: bractlets broadly crested.*

5. G. GLOBOSA L. Sp. Pl. 224. 1753.

Distinguished from the next by its broad leaves, slender fibrous roots, and uniformly globular heads with broadly winged blunt bractlets.—Native of India, introduced into tropical America. Type unknown.

6. G. TUBERIFERA Torr. Bot. Mex. Bound. 181. 1859.

Stems erect from a fusiform fleshy and farinaceous root: leaves lanceolate to linear: peduncle elongated, simple: heads globose or oblong-ovate: flowers shining, pale rose-color: calyx about equalling the narrowly keeled broadly crested bractlets: sepals very acute.—On the rocky banks of the San Pedro and other western tributaries of the Rio Grande. Types in herb. Gray, Columbia College and Nat. herb.

* * * *Stigmas filiform on a long style: bractlets thin, keeled, but without crest or laciniæ.*

+ *Stems very long, with conspicuously swollen joints: heads small, often aggregated.*

7. G. SONORÆ Torr. Bot. Mex. Bound. 181. 1859.

G. decipiens Wats. Proc. Am. Acad. 21: 437. 1886.

Stem tall, jointed, trichotomously branched, from a straight ligneous tap-root: leaves rather narrow, acute, 3 to 6^{cm} long, tapering into a winged petiole: both axillary and terminal heads mostly composed of two or three closely aggregated small heads, bractlets keeled, not crested, slightly longer than the sepals, easily deciduous, leaving the woolly flowers exposed.—Southern Arizona and Sonora. Types in herb. Gray, Columbia College and Nat. herb. (no. 1749 *Wright*, collected at Santa Cruz, Sonora).

Torrey's description of *G. Sonoræ* was founded on no. 1749 Wright and certain Thurber specimens of the same vicinity and date. But Wright 1749 was erroneously supposed to have serrate crested bractlets. Drawings on the label of the Columbia College specimen of Wright showing the cristate character must have been based on a Thurber specimen, resulting from confusion of material. The only Thurber specimens seen of that date and locality (1013 and 946) were properly referred by Dr. Watson to *G. nitida.* We have examined numerous other specimens correctly labelled *G. Sonoræ*, all of which agree with the Wright type in the absence of crested bractlets. In consequence of the absolute identity of the type of *G. decipiens* Wats. (*Palmer* 27 of 1885 in herb. J. D. Smith and Nat. herb.) with these specimens, we have been led to reduce *G decipiens* to a synonym of *G. Sonoræ.*

+ + *Low and cespitose.*

8. G. CAESPITOSA Torr. Bot. Mex. Bound. 181. 1859.

Very low, white villous, cespitose, spreading with thick woody caudex: leaves obovate, obtuse, the radical with attenuate base, the two cauline subsessile: peduncles short and simple: heads ovate, about 2^{cm} long, usually not subtended by leaves: flowers shining, yellowish white: bractlets hyaline, not keeled.—Mountains of New Mexico, Arizona, and Sonora. Types: *Wright, Bigelow*, 1752, 1753, in herb. Gray, Columbia College and Nat. herb.; *Thurber*, 256 of 1851, in herb. Gray and Columbia College; *Capt. E. K. Smith*, in herb. Columbia College; *Schott*, in herb. Columbia College.[3]

Herbarium Lake Forest University.

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[3]**Gomphrena Tuerckheimii.**

Telanthera Tuerckheimii Vatke, Ind. Sem. Hort. Berol. 187–, *fide* J. Donnell Smith.

Tall branching perennial with tetragonal stem: leaves short-petioled, ovate, acute, densely appressed-sericeous below, scabrous above: heads small (less than 1^{cm} in diam.), hemispherical: sepals prominently 3-nerved, lanceolate-acute, three times longer than the three equal bracts and the enveloping hairs: stigmas short, sessile, erect.

The above description is based on a specimen in herb. J. D. Smith (Guatemala, Coban, Depart. Alta Verapaz, *Tuerckheim*, 416 in 1885) which he has identified as *Telanthera Tuerckheimii* Vatke. Having seen neither the type nor any published description, we base our conclusion regarding it solely on the determination of Mr. Smith, who evidently thought this to be the same as Vatke's plant. If he is correct, Vatke's species undoubtedly belongs with *Gomphrena.* But if he was mistaken in their supposed identity then our plant becomes a new species of *Gomphrena.*

A reply to Dr. Robinson's Criticism of the "List of Pteridophyta and Spermatophyta of Northeastern America."

FREDERICK V. COVILLE.

It is with great regret that I have found myself called upon, under circumstances that make compliance a necessity, to reply to Dr. Robinson's criticism, published in the preceding number of this journal, on the List of Pteridophyta and Spermatophyta Growing without Cultivation in Northeastern North America, prepared by a Committee of the Botanical Club, American Association for the Advancement of Science. My hesitation is due to a feeling that nomenclatural discussions are often of little value, tending as they so frequently do to the expression of mere individual custom and prejudice. Since, however, I have never before put into print, except as a member of a committee, any statement of belief regarding principles of nomenclature, and have never published a controversial line on the subject, while at the same time I have been an active worker in the reform of our botanical nomenclature, I hope that I may not be accused unjustly, as others have been, of having thought little and written much.

First I must protest against Dr. Robinson's assumption, which pervades his whole article, that Dr. Britton, chairman of the check-list committee, is its real author, and that the other eight members were largely ornamental, if I may be permitted to use that word. In order that a false and injurious impression of this matter may not be further disseminated, it should be stated at once, that after another member of the committee had endeavored unsuccessfully to provide means for publishing the manuscript, as submitted by various members of the committee and by others, Dr. Britton consented to undertake the task and issue the publication from New York. The editorial work and the final verification of references fell therefore largely to Dr. Britton. Galley proofs were always sent, however, to each of the editors, and no small amount of time was spent by them in annotations and corrections and the verification of marked references.

If Dr. Robinson, furthermore, intended to express the opinion that Dr. Britton alone is responsible for the principles

upon which the nomenclature of the check-list is based I must again protest. Not one of the principles therein incorporated is original either with Dr. Britton or with any other member of the committee, but all of them have been in practice in this or in other branches of biological science before the present code was formulated. More than this, some of the botanists who afterward became members of the committee had become definitely convinced of the validity of the main principles finally adopted, long before Dr. Britton had given expression to them. Dr. Britton has been most active and influential in *hastening* the reform of nomenclature in botany, and he has borne unflinchingly the brunt of criticism. It is therefore a matter of congratulation to him that the principles he has advocated have coincided in the main with those which have stood the test of experience in other branches of science and which have appealed also to the judgment of his fellow botanists.

Several years ago, when my own views on principles of nomenclature were in a formative stage, I had the good fortune to ask the eminent ichthyologist, Dr. David Starr Jordan, now president of Stanford University, what he considered the fundamental requirement of a stable system. His characteristic reply was, "There are only two ways of naming plants or animals, either to give them their oldest names or to give them any names you please." This epigrammatic statement represents well the difference between the new and the old systems. By the old, the standard is a moving one, changing from decade to decade in meeting the literary taste and custom of the time, or in conforming with the individual liking—too often arbitrary or capricious—of some stronger and more prolific writer. By the new system, on the contrary, the standard is a fixed one, and the possible errors of early practice are open to later correction, while the rare cases that do not appear to admit of decision by rule are necessarily in a position to be fully discussed and ultimately disposed of by agreement.

The detailed criticisms made by Dr. Robinson can not for want of space and time be discussed here, nor are they pertinent to the principles involved. Whether the name *Konig* or *Koniga* is the correct one, whether we shall write *Butneria* or *Büttneria*, whether the binding of a separately paged supplement at the beginning of a book makes it no longer a supple-

ment, or whether albinos shall be treated as forms or as varieties, all these are proper matters for the expression of opinion and argument. I know that the committee would have been grateful and would still be grateful to Dr. Robinson or any other botanist for useful suggestions on these matters, and that all communications of this kind would receive fair hearing and sober judgment.

For the errors of citation which Dr. Robinson has pointed out it is hardly necessary to apologize. Those who have systematically verified by consultation of original sources of publication all the page and plate references in any group of plants of even moderate size, will appreciate the enormity of the task that devolved upon the committee in dealing with more than 10,000 references, ninety-eight per cent. of which were finally verified. But all errors in the book will be rectified hereafter, and while the few that now occur may be temporarily annoying to the botanist who uses the list, they have nothing to do with the principles themselves.

With reference to Dr. Robinson's criticism that the check-list differs from current standards in its conception of genera and species, I wish again to point out that, while the check-list is more nearly in accord with the highest recognised authority, Engler and Prantl's Natürlichen Pflanzenfamilien, than is any local or general descriptive American work, this fact has nothing to do with any system of nomenclature whatever and is not used justly as an argument in this case. Nor has the committee offered this treatment of genera and species as representing their combined judgment, for the contributor of each family is specifically and designedly named. The contributor is responsible for the matter, the committee for its presentation in proper form under the principles adopted by the club. Whether Astragalus and Phaca shall be treated as distinct genera as most European botanists treat them, or whether they shall be thrown into one, as most American botanists have held heretofore, is a question on which the contributor of the Leguminosæ, not the committee, has expressed an opinion. But all this aside, the disagreement between the contributors and Engler and Prantl are exceedingly few.

I must correct one lamentable error into which Dr. Robinson has fallen through a misinterpretation of one of the fundamental principles of the new system. He says (p. 101):

"It will always be possible for an erratic botanist to throw together large genera like *Aster* and *Erigeron*, *Bidens* and *Coreopsis*, *Panicum* and *Paspalum*, thereby displacing many specific names which according to the rule of "once a synonym always a synonym" can never be revived. This outcome seems so preposterous that it must be stated that it is not merely the writer's own unauthorized interpretation but the distinctly expressed although unpublished view of one of the compilers of the list, who has been among the foremost in the cause of nomenclature reform."

I fully agree with Dr. Robinson that the outcome he depicts would be preposterous, and I take this opportunity to point out his error, feeling also some responsibility for not having made the case clear to him formerly. The phrase "once a synonym always a synonym" is unfortunate and misleading, and I have preferred to substitute for it in conversation the equivalent phrase, "the rejection of homonyms." The principle is simply this, that after a name has once been published, the same name shall not again be a valid designation for any other plant, even though the original name should meanwhile have become a synonym of some other still older name. For example, the name Bigelovia has been applied to five or six widely scattered genera, all the earlier of which have been referred to other still older genera. The rule of the rejection of homonyms renders the name Bigelovia, therefore, unavailable for the genus to which it has been applied in recent years, and the check-list consequently takes up the next older name, Chondrophora. The force of the rule may be illustrated by the fact that by the old system, if any one of the earlier genera named Bigelovia should at any time be revived, it would necessitate a change also in the name of the later and current Bigelovia. There are many cases in which under the old system the revision of a family and the consequent necessary revival of some old generic name would entail changes in the names of two or three other genera as well. Under the new system a change in one generic name can not affect any other genus. Moreover, quite the opposite of Dr. Robinson's supposition, a restoration of the name Bigelovia would be perfectly valid, under this system, should the genus to which it was first applied be found really autonomous and therefore require a separate designation.

It is to be regretted that Dr. Robinson did not, while at the Madison meeting, bring forward for discussion his questions as to principles, for they undoubtedly were well understood,

and would have been ably explained, by many of the botanists present. Now that they have been adopted by overwhelming majorities in democratic botanical assemblages, we may well ask whether Dr. Robinson's protest is not out of place, and whether he has any available substitute to offer or improvement to suggest. He surely cannot expect American botanists to revert to a now discredited system of nomenclature under which they had been chafing more and more for the past fifteen years.

Dr. Robinson's remarkable statement of opinion that stability is not the most important quality of nomenclature, fills me with amazement. After a reconsideration of this view, having in mind the relation which must exist between stability and ready intelligibility, he surely will not attempt to maintain such a position.

Dr. Robinson's statement (p. 103) that uniformity, consistency, and stability of nomenclature are in his opinion unattainable, confirms my impression that he has only the faintest conception of the strength of the new principles or the community of opinion of which this simple list is the expression. One by one our botanists have become convinced that the new system *is* adequate to the requirements, and I cannot believe that Dr. Robinson, when he fully grasps the intent and the working of this code, can fail to be convinced of its utility. It would require too much space to recount the history of the new system, receiving successive impulses as it did from Henry and Arthur Adams in 1858, in conchology; from our own illustrious Baird in the same year, in ornithology; from the now venerable Dr. Gill in 1861, in ichthyology; and in the past twenty years perfected by other eminent biologists with whose names and work we are familiar. The Rochester meeting of botanists was held in 1892, the Madison meeting in 1893, and now in the spring of 1895 we are able to cite the following as some of the organizations which have already issued publications incorporating essentially the same principles of nomenclature as those under which the committee carried on its work.

United States National Museum.

United States Department of Agriculture, Division of Botany and Division of Forestry.

Arnold Arboretum.

Missouri Botanical Garden.

Columbia College Department of Botany.
Torrey Botanical Club.
Nebraska State University and State Botanical Survey.
Indiana State Botanical Survey.
University of Minnesota and State Natural History Survey.
University of California.
University of Wisconsin.
University of Ohio and State Botanical Survey.
Kansas Agricultural College.
Systematic Botany of North America.
Eli Lilly & Co., drug dealers.
United States Official Pharmacopœia of 1890 (the last issued).
Sargent's Silva of North America.

The directors of many other botanical establishments, many scientific serials, and a very large number of individual botanists have also published in conformity with the same principles. Thus the new system seems to have those marks of early virility which are usually possessed by long needed and stable reforms.

To hold that the ornithologists—to draw an illustration from a popular science—have not a more useful or stable nomenclature than formerly, or that they regret their reform, or that the movement has brought its early supporters into popular disrepute, or that the revised names are now considered objectionable, is to question matters of fact.

In closing, therefore, I feel justified in expressing the hope that Dr. Robinson and the few who think with him on this subject will lay aside personal prejudices and join the remaining nine-tenths of our botanists and almost all our conchologists, ichthyologists, herpetologists, ornithologists and mammalogists, in a nomenclature based on scientific needs and a scientific method.

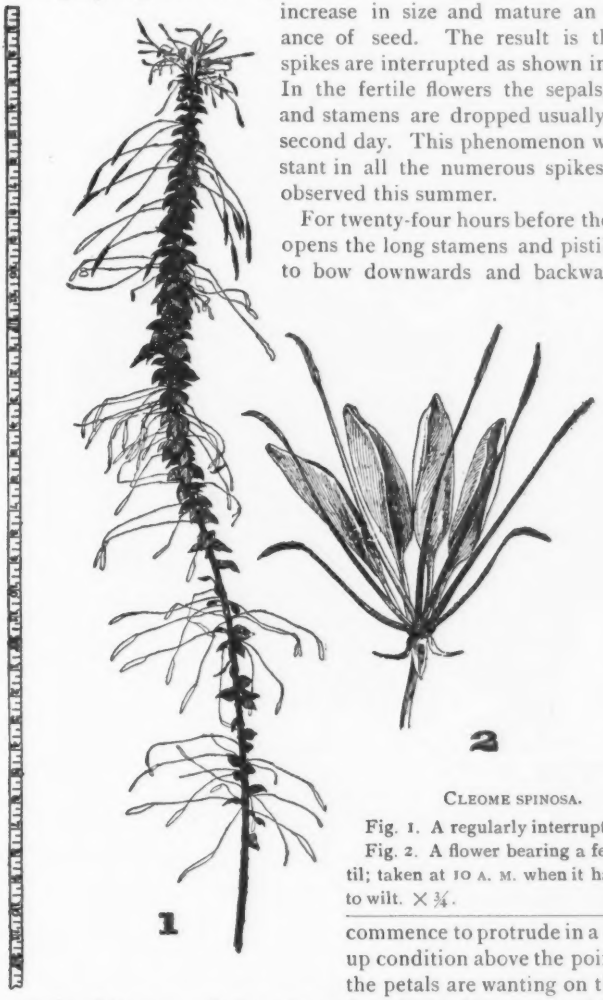
United States National Herbarium, Washington, D. C.

BRIEFER ARTICLES.

Observations on the spider flower.—*Cleome spinosa* L. is a tropical American annual, which has long been cultivated in flower-gardens for its curious spider-shaped flowers. In this vicinity it has escaped to rich neglected places about dwellings. Its especial choice is a neglected wood-yard or some uncultivated rich spot just outside the barnyard. I have in mind several such places where it has appeared annually for the past twenty years, so that it may be said that it is thoroughly "introduced." The plant begins to bloom in July, and continues until frost. It attains a height of from four to six feet; the branches are long and spreading or drooping. The inflorescence is centripetal and terminal, and consists of long lax spikes of purplish-pink spreading flowers. The bracts are large and foliaceous in the fruiting spike. The peduncles are usually 33^{mm} long; the stipes are slender and about 55^{mm} long; the pod, when ripe, is near 50^{mm} long. There is a row of seeds along the ventral and another along the dorsal side of the pod or legume. When mature the valves fall off, the seeds are dropped and scattered, but the ribs along which the seeds grew remain; these with the stipes and peduncles are spreading and slightly pendent on the rachis. See Fig. 1. There are four sepals which are 8^{mm} long, and are reflected when the flowers are opened; they are early deciduous. The petals are four in number, 33^{mm} long, ovate-oblong and clawed; their attachment to the torus takes up about four-fifths of a circle, the lower fifth is not occupied. When fully opened they spread outwards and upwards at an angle of about 45°, so that their outer points form about two-fifths of a circle; the lower three-fifths of the circle being occupied by the stamens, the two forming an inverted cone whose apex is at the torus. The stamens are usually 55^{mm} long, six in number, and are arranged in two sets of three each; one set on each side of the pistil. They spread outwards at the same angle that the petals do, and fill up the lower three-fifths of the cone formed by them and the petals. The pistil stands in the center of the cone formed by the four petals and six stamens; it varies in length, when the flowers first open, from 12 to 80^{mm}. The pistils develop in two series; for several successive days there will be only short or sterile ones, then for a number of days only long or fertile ones on a given spike. All the pods contain immature and unimpregnated ovules when the flowers first open, but the pistils that are short do not develop further, and soon the whole flower drops off,

leaving nothing but the empty bract; while the pods of the long ones increase in size and mature an abundance of seed. The result is that the spikes are interrupted as shown in Fig. 1. In the fertile flowers the sepals, petals and stamens are dropped usually on the second day. This phenomenon was constant in all the numerous spikes I have observed this summer.

For twenty-four hours before the flower opens the long stamens and pistils begin to bow downwards and backward and commence to protrude in a doubled up condition above the point where the petals are wanting on the lower margin of the torus, their upper ends being held down by the convolutely folded petals until shortly after sunset. At this time the petals gradually unfold and liberate the stamens and pistil. The pistil



CLEOME SPINOSA.

Fig. 1. A regularly interrupted spike.

Fig. 2. A flower bearing a fertile pistil; taken at 10 A. M. when it had begun to wilt. × ¾.

assumes an erect position while the stamens with the petals spread outward and form the inverted cone described above. The anthers do not open until about dusk, when every thing is ready for the welcome visitors. These are attracted by a large drop of delicious nectar lodged between the bases of the petals and the pistil, on the torus. The repast is advertised by the four bright purplish-pink petals which stand just above it. These remain open the whole night, but as the sun rises the following morning their bright color begins to fade, and they with the stamens commence to droop, by the end of thirty-six hours they are ready to drop.

The whole plant is covered with a glandular pubescence and gives off a rank disagreeable odor; while the flower alone has a slight pleasant balsamic odor.

Its principal visitors are the various species of humming-bird moths, humming-birds, honey bees and a number of wasps. The first and second of these appear to be the most beneficial, and are the most frequent visitors. In the act of taking honey both usually poise on their wings before the flower; in doing so the circle of motion formed by the outer points of the wings is just inside of the inverted cone formed by the six stamens and four petals. The pollen is thus scattered in all directions and thrown on the stigmas which are just ready to be fertilized.

Another interesting phenomenon observed was that as the cool nights of autumn came on the stamens grew shorter and finally before they were killed by frost the anthers were nearly sessile, while the pistils continued to be either long or short as during the summer.

I am unable to give a satisfactory explanation of the regular interruptions of the spikes. At first I thought it was due to wet and dry periods, but further observation has contradicted this theory. Besides the various spikes on the same plant are frequently in opposite stages, some bearing short abortive pistils in their flowers, while other spikes are producing long and fertile forms.—J. SCHNECK, *Mt. Carmel, Ill.*

Observations on Enslenia albida.—WITH PLATE XIII.—In *Enslenia albida* Nutt. one of the axillary buds at each node is much stronger and more forward than the other, and forms branches while the other remains almost or quite latent. At first the weaker bud can scarcely be seen, but it becomes more prominent later and may finally develop several internodes, but never makes such great growth as the stronger, unless injury to the terminal and other axillary bud necessitates its further development. The more potent axillary buds form a continuous spiral, either right or left, and frequently right and left on different branches of a single plant.

An alternate pubescent line found on the stem is always on the side of the axis on which the stronger axillary bud occurs, and on the first internode of each branch on that side of the branch next the axis from which it arises. In rare instances the two axillary buds were found almost equally developed, in which case the main axis has two pubescent lines. As these strong axillary buds are apparent even before the leaves to which they are axillary unfold, they are an obstacle to free growth and also points of greatest pressure in the bud. It would seem from this that the utility of pubescence is in this case to protect the delicate forming parts from the effects of pressure and friction in the bud.

In accordance with this view the axis, which has a more rapid growth than the leaves, has its pubescence directed downward, while that of the leaves is directed upward toward the apex, thus offering the least possible resistance to growth.

Both Gray[1] and Wood,[2] in their descriptions of this plant, say that the flower-clusters are axillary, but it appears that the peduncle arises not from an axillary bud but at the side of the axillary bud which is in its normal position. The absence of the axillary bud of the opposite leaf explains this apparent anomaly. Instead of the flower-cluster arising from an axillary bud it terminates the axis and each succeeding internode of the stem arises from the stronger axillary bud of the preceding internode.

Gray describes the inflorescence as a raceme-like cluster and Wood calls it a racemous umbel. The raceme and umbel both properly belong to the indeterminate or botryose type of inflorescence, while the flower-clusters of Enslenia follow out the same determinate plan exhibited by the terminal position of the peduncles. This results in that form of the scorpioid cyme known as a bostryx, development following the same spiral in the inflorescence as that noted in the stem; thus the plane of each pedicel is at right angles to that preceding, and the fifth internode bears a flower opposite the first, and the sixth opposite that borne by the second, etc.

The development of the weaker axillary bud into a flower doubles the number of flowers in the spiral and thus it occurs that the ninth flower stands opposite the first.

Anthesis takes place in the order of the successive divisions of the axis and is in this order: first, third, fifth and second, seventh and fourth, ninth and sixth, etc., each pair of numbers corresponding to the buds arising from one node.

[1] Manual of Botany 343. 1889. [6th ed.].
[2] Class Book of Botany 595. 1880.

The pollinia are quite small and occupy only the upper portion of the anther. They are almost cylindrical and are attached to the anther by placentæ which break away with the pollinia forming a hyaline line along their outer sides as arranged in pairs.

The pollinia of Asclepias with which they are usually compared are larger, occupying the anther from base to apex. They are quite flat and do not exhibit the hyaline line seen in Enslenia.—GEO. H. SHULL, *Sulphur Grove, Ohio.*

EXPLANATION OF PLATE XIII.—Fig. 1. *Enslenia albida* Nutt., a node and cluster of flowers. × 1.—Fig. 2. Diagrammatic view of the inflorescence reduced to a single plane.—Fig. 3. Anther with its appendage. × 10.—Fig. 4. Section near the summit of the central column showing the arrangement and attachment of the pollinia. × 27.—Fig. 5. Section near the base of the central column showing anthers quite empty. × 27.—Fig. 6. Pollinia. × 32.—Fig. 7. Pollinia of *Asclepias incarnata* L. × 32.

On the development of the bulb of the adder's-tongue.—WITH PLATE XIV.—In the BOTANICAL GAZETTE for February, 1894, I presented results of observations made in 1893, upon the adder's-tongue, or spring Lily (*Erythronium Americanum* Ker.), and will here add, results of observations made in 1894 in hopes that as soon as the weather admits others will begin to make observations that may aid in determining questions of growth.

Here at New Brunswick, N. J., the flowers are about a week later than in the vicinity of Washington, D. C., and nearly a week earlier than in the vicinity of Springfield, Mass., the blossoms of the Erythronium being about their prime here on April 27th last year; the runners being at their best about May 5th, and the seeds ripe June 13th. The seeds are not easily found except when the exact spot where the plants grow has been previously noted carefully, for very soon after blooming the plants begin to decay and often the seeds ripen with the ovary on the ground, the remnants of the plant being prostrate and partly hidden by later growths of vegetation. By the first of May the profusion of bloom had passed and buds were found only in sheltered spots.

In the vicinity of Washington the anthers of *E. Americanum* Ker. observed were almost invariably dark brown; here the anthers observed were most frequently yellow, although the brown anthers were not rare. No direct relation was observed between the color of the anthers and the blotching on the leaves, as dark anthers were found on some plants whose leaves were free from brown, but freely blotched with white. The yellow anthers are often found associated with leaves thickly sprinkled with brown spots. All stages between these two extremes were found. As regards fertility, no comparative

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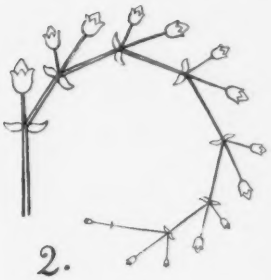

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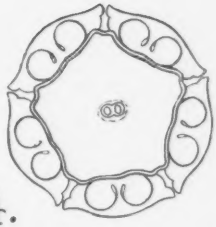

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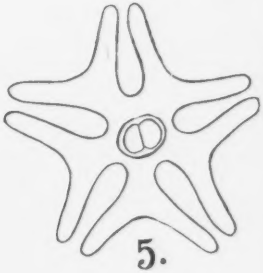

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SHULL on ENSLENIA.

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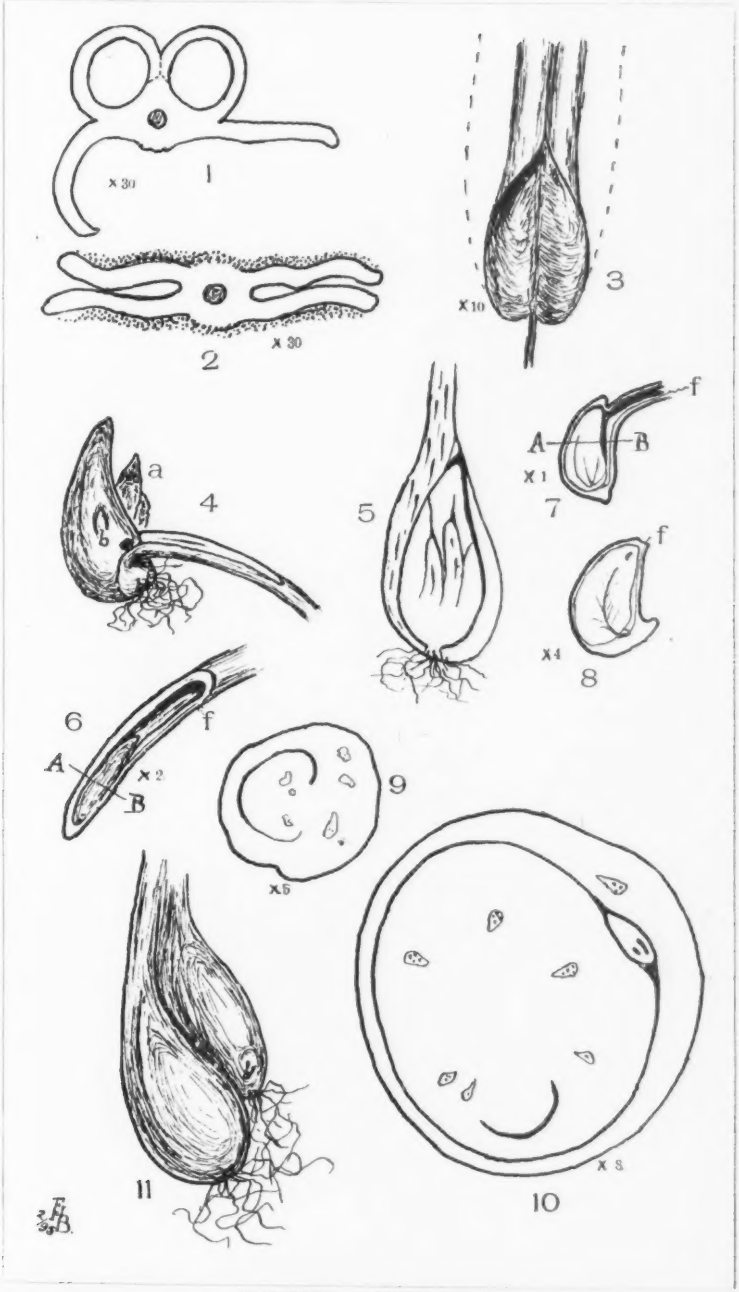

BLODGETT on ERYTHRONIUM.

THE
JOHN CREAR

laboratory experiments have been made here as yet, but the plants in the fields have about the same size of ovary in the case of the yellow as in the case of the brown anthers; but the best development reached by any of the plants seen was in those having yellow anthers. These grew in a cool, shady ravine, and within a few feet were other plants having brown anthers, which were but slightly inferior in development.

Nearly seventy-five plants were examined in the field on May 3d, all of which had yellow anthers. These were in various stages, from the recently opened flower to the blossom that had fallen to the ground, but age did not seem to have any effect on the color of the stamens.

The anther opens not by the throwing of the adjacent lateral pollen chambers together, but by the dividing of the dorsal and ventral partitions inward until the elasticity of the walls ruptures the thin remaining portion.[1] The upper half of fig. 1 illustrates by dotted lines the approximate path of such a rupture. This process begins at the base of the dorsal suture and extends upward, as shown in fig. 3, the dotted line indicating the probable position of the walls when fully opened. A transection of a fully opened anther is shown in fig 2. The pollen covered surface is thus exposed to the wind and insects.

The active mature bulb of one year seems in some cases to be developed from a bud of the previous year, the parent bulb being absorbed in the growth of the bud. Remains of this parent bulb are sometimes adherent to the new bulb, and such a case is shown at *a*, fig. 4. Here the husk has been carefully removed, and the sheathing stalk bent back to show more plainly some details. At *b* is a bud already started although the bulb on which it occurs has not fairly begun its independent life. Figure 5 gives a longisection of a similar bulb showing the young bulb found within the active portion, which is marked with the vascular bundles.

If two buds should develop from the same parent at the same time, there might be produced a growth similar to that in fig. 11, but such contact developments are more likely to occur by the growth of two runner-bulbs in contact.

On account of botanical work at Cottage City, Mass., I could not continue my collecting during the summer, but my father, Mr. James H. Blodgett, kindly collected, at various dates ending with November 28th, over six hundred bulbs of all sizes, from marked spots near Washington, D. C. This collection contains two cases of the "contact developments." One of these is represented at fig. 11, and under careful examination they show no break in the husk; a small bud is

[1] This process is described by Van Tieghem, Traité de Botanique, 832.

developing near the base of the upper one and is pointed downward. It is the first case noticed in which this occurred. That the secondary bulbs are really buds from the primary but immature bulbs, is shown by the structure of the runner-tip. This tip forms the terminal bud of the runner and is shown in fig. 6. The runner is hollow for nearly its full length when in its best condition, the tube tapering toward the upper part. Through the runner some vascular-bundles extend. These are more highly developed near the parent bulb than at the tip, and are surrounded by cells which contain a supply of starch. In a section of a runner-tip at a point corresponding to *A B*, fig. 6, a structure like fig. 9 is seen, the irregular patches being the bundles, and the line cutting off a portion being the boundary of the bud within the runner. Some of these runner-buds in shape closely resemble the seeds, (compare fig. 7 a bud and fig. 8, a seed). Figure 7 shows a longisection of a runner-bud, natural size, as it reaches its full development as a bud. It is now ready to absorb the runner and becomes a bulb.

The bundle, *f*, is seen running down to the base of the bud, and is also shown in a similar position in the seed. The soft spongy portion of the seed is directed away from the placenta, as the point of the bud, just above, is away from the runner. In figs. 9 and 10, in a section of a bud similar to the trans-section *A B* of figs. 6 and 7, the structure is seen to be more highly developed, bearing a resemblance to the bulbs themselves. The bundles are more differentiated and more numerous, and the bud has begun to develop its internal sprout.

The growth of fleshy fibers from the upper part of the runner-bud, (See Bot. Gaz. 19: *pl. 7. fig. 11.* 1894.) noted in 1893 has not been seen since, but such fibers were well developed in that specimen.

As the fibrous roots at the base of the mature bulbs are persistent through the year they are ready to start with the warm weather so that the plants have means for very rapid development, when spring opens.

The immature bulbs develop their roots in order of their size, the smallest not producing theirs until the latter part of October, between October 26th and November 15th, in 1894.

Among the plants collected by the students of Rutgers College last spring one Erythronium was brought in having two flowers, on separate pedicels, but springing from the same point of the plant, which was otherwise normal. In the general herbarium of the institution is a plant bearing a third leaf, which springs from the stem just below the separation of the normal leaves. This third leaf is considerably smaller than either of the others. Another plant has a blossom, with

the bulb less than an inch and a half below the surface. It was apparently trying to get deeper, as a strong runner had started from the bottom of the bulb.—FREDERICK H. BLODGETT, *Rutgers College, New Brunswick, N. J.*

John H. Redfield.—The death of Mr. John H. Redfield, conservator of the herbarium of the Academy of Natural Sciences of Philadelphia, which occurred in that city on the twenty-seventh of February, is regarded as a serious loss to the science he loved. He was for many years a member of the car-wheel manufacturing firm of that city, Asa Whitney & Sons, the founder of the firm being his father-in-law. His spare time from his business was devoted to self-culture, especially to learning languages, and studying natural history. He became a thorough Greek and Latin scholar, and continued the acquisition of modern languages through life, having mastered Spanish but a few years before his death. In natural history he was proficient in chemistry, mineralogy, conchology, and botany—the later years of his life being wholly devoted to the latter pursuit. In the knowledge of ferns he had few superiors anywhere, and workers in this group of plants were always happy in examining his rare collection, and profiting by his wide knowledge. The greatest monument to his labors will be the herbarium of the Academy of Natural Sciences of Philadelphia.

He retired from active business in 1885, and from that time devoted his whole time to building up this herbarium. Though with good material collected by many eminent men, it was in a sad state in the early sixties. On the death of Elias Durand, only one worker was left to give a few hours a day to its care. Its condition may be imagined by the reply of Dr. Gray to an application for a share in some specimens, "what is the use of throwing valuable material into a dust bin?" The letter, shown to Mr. Redfield, stirred a strong desire to give encouragement. During his noon recess from business he would call to enquire how the work was coming on. From this beginning he left the herbarium at his death with over 35,000 species of flowering plants and ferns, accurately determined, with many suites of specimens to show geographical range and variations, with a very large number undescribed. He had undertaken the immense labor of verifying and fastening to sheets the huge collection, and had more than half completed the task, leaving an unfinished genus on the table to take to his death bed. By his will he leaves all his books and collections of natural history to be sold, the proceeds to be devoted to continuing the work on the herbarium. This will start a "Redfield Memorial Hebarium Fund," by which the memory of his unselfish labors will be perpetuated.

He was born July 10, 1815, at Middletown, in modern times Cromwell, Connecticut. When a young man became acquainted with Prof. Torrey in New York and Dr. Gray, through membership in the New York Lyceum of Natural History. In 1846 he was elected to membership in the Philadelphia Academy. Always declining election to any high honors in the institution, he was glad to fill positions of usefulness. He served long as one of the Council of Management, and at his death had filled for many years the responsible position of chairman of its publication committee. Eminent botanists from many parts of the world made their calls on him when passing through Philadelphia.

"The Flora of Mount Desert Island, Maine," was his latest work, prepared in conjunction with his friend Edward L. Rand, and issued last year. The modesty of his nature may be inferred from the subtitle, "A Preliminary Catalogue," as no more complete local flora has probably been issued. He derived much satisfaction in his last days from the numerous letters commending the stand taken in that work against violent changes in plant nomenclature, his main point being the impossibility of practically carrying out without endless confusion that which might be correct as an abstract proposition. The Academy will soon publish a memoir giving an abstract of his life and services to science. In the language of one of his colleagues, "an association of the past eight years made me familiar with his beautiful character. He was always high principled, single-hearted, charitable, kind and helpful,—an affectionate friend, a wise counsellor, an upright judge." —THOMAS MEEHAN, *Germantown, Philadelphia.*

George Hunt.—In the death of Mr. George Hunt botanical science in Rhode Island has met with an irreparable loss. For over sixty years he has been familiar with every bog and wood in the state. When over eighty he could outwalk all his younger companions. He never seemed to know fatigue. Even for the nooning he never sat down, but ate, and that sparingly, while searching the rocks or glens.

He was a true wood-lover. The plants seemed to guess his feeling and to do their very best for his delight. For many years he was the chosen guide of some of us younger men, who all loved him with tender regard. His character was as sweet and pure as the aroma of the mayflower. It was a precious privilege to accompany him on a walk. Each year we went with him to welcome the hepatica. Sweet, unobtrusive, gentle, he could be roused to earnest remonstrance, or to contest a wrong. He was eminently a right minded man and a true gentleman.

He was one of the earliest members of the A. A. A. S., and always glad to attend its meetings. He was a life-long member, too, of the Rhode Island Horticultural Society, and the Providence Franklin Society, and a member of that group of Rhode Island botanists that included at one time George Thurber, J. W. Bailey, S. T. Olney and A. L. Colder. He was personally known to doctors Torrey and Gray, and had sent specimens to Harvey. As was often the case in those early days, he had embraced several sciences and divided his life between entomology and botany. In his garden he grew the most precious wild flowers and made every one welcome to their enjoyment. He passed away on Feb. 21st at the ripe age of eighty-four.—W. WHITMAN BAILEY, *Providence, R. I.*

The Systematic Botany of North America.—The Board of Editors of the "Systematic Botany of North America" announce the following arrangements for the presentation of groups thus far decided on. Other assignments will be reported as made, and also such changes as may arise in the present arrangement. It is requested that collectors communicate material for study to the monographers, even of the commoner and well-known species, so that the geographical distribution may be presented as accurately as possible.—N. L. BRITTON, *Chairman, Columbia College, New York.*

Myxomycetes: Mr. O. F. Cook, Huntington, N. Y. (at present abroad).
Schizomycetes: Prof. H. L. Russell, University of Wisconsin.
Chlorophyceæ: In charge of Prof. Geo. L. Atkinson, Cornell University.
Phycomycetes: Prof. Byron D. Halsted, Rutgers College, New Brunswick, N. J.
Saccharomycetes: Dr. J. Christian Bay, State Board of Health, Des Moines, Iowa.
Taphrineæ: Prof. Atkinson.
Helvellineæ: Prof. Lucien M. Underwood, Greencastle, Ind.
Pezizineæ, Phacidineæ: Mr. Elias J. Durand, Cornell University.
Fungi Imperfecti: Prof. Halsted, and Mr. J. B. Ellis, Newfield, N. J.
Ustilagineæ: Prof. Halsted.
Uredineæ: Prof. J. C. Arthur, Purdue University, La Fayette, Ind.
Polyporineæ: Prof. Underwood.
Boletineæ, Agaricineæ: Prof. Chas. H. Peck, State Museum, Albany, N. Y.
Gasteromycetes: Mr. A. P. Morgan, Preston, Ohio.
Hepaticae: Prof. Underwood.

Musci: *Acrocarpi*, Mrs. N. L. Britton, Columbia College; *Pleurocarpi*, Prof. C. R. Barnes, University of Wisconsin; *Sphagnaceæ:* Mr. John K. Small, Columbia College.

Pteridophyta: Prof. Underwood.

Typhaceæ, Sparganiaceæ, Naidaceæ, Juncaginaceæ: Manuscript of the late Dr. Thos. Morong.

Alismaceæ: Mr. Jared G. Smith, Missouri Botanical Garden.

Hydrocharitaceæ: Manuscript of Dr. Morong.

Gramineæ: In charge of Prof. F. Lamson-Scribner, U. S. Department of Agriculture.

Cyperaceæ: Prof. L. H. Bailey, Cornell University, and Prof. N. L. Britton, Columbia College.

Araceæ: Manuscript of Dr. Morong.

Lemnaceæ: Mr. E. P. Sheldon, University of Minnesota.

Eriocaulaceæ: Manuscript of Dr. Morong.

Commelinaceæ: Mr. J. N. Rose, U. S. Department of Agriculture.

Juncaceæ: Mr. F. V. Coville, U. S. Department of Agriculture.

Liliaceæ: Mr. J. N. Rose.

Smilaceæ: Manuscript of Dr. Morong.

Dioscoreaceæ: Prof. A. S. Hitchcock, Kansas Agricultural College, Manhattan, Kansas.

Saururaceæ, Piperaceæ, Casuarinaceæ: Mr. T. H. Kearney, Jr., U. S. Department of Agriculture.

Juglandaceae: Prof. Britton.

Myricaceae: Prof. Britton.

Leitneriaceae: Prof. Wm. Trelease, Missouri Botanical Garden.

Salicaceae: Mr. M. S. Bebb, Rockford, Ill. (*Salix*).

Betulaceae, Fagaceae, Ulmaceae, Moraceae: Mr. Geo. B. Sudworth, U. S. Department of Agriculture.

Urticaceae, Loranthaceae, Santalaceae, Olacaceae, Aristolochiaceae: Mr. T. H. Kearney, Jr.

Polygonaceae: Mr. John K. Small.

Chenopodiaceae: Mr. Willis L. Jepson, University of California.

Amaranthaceae: Messrs. E. B. Uline and W. L. Bray, Lake Forest University.

Phytolaccaceae: Prof. Hitchcock.

Portulacaceae: Mr. Jepson.

Nymphaeaceae: Prof. Chas. A. Davis, Alma College, Alma, Mich.

Ranunculaceae: Prof. Britton.

Menispermaceae: Prof. Hitchcock.

Calycanthaceae: Mr. T. H. Kearney, Jr.

Geraniaceae, Oxalidaceae, Linaceae: Prof. Trelease.

Malpighiaceae, Zygophyllaceae, Rutaceae: Miss Anna M. Vail, Columbia College.
Simarubaceae, Burseraceae, Meliaceae: Mr. Sudworth.
Polygalaceae: Dr. Wm. E. Wheelock, Columbia College.
Callitrichaceae: Studies of Dr. Morong.
Malvaceae: Mr. J. Burtt Davy, University of California.
Guttiferae, Hypericaceae: President John M. Coulter, Lake Forest University.
Cistaceae: Prof. Britton.
Empetraceae: Prof. Hitchcock.
Limnanthaceae, Aquifoliaceae, Celastraceae, Hippocrataceae, Staphyleaceae, Aceraceae, Hippocastanaceae, Sapindaceae, Balsaminaceae: Prof. Trealease.
Rhamnaceae: Mr. Jepson.
Vitaceae: Prof. L. H. Bailey.
Loasaceae: Dr. Wheelock.
Cactaceae: President Coulter.
Thymeleaceae, Eleagnaceae: Prof. Hitchcock.
Halorageae: Studies of Dr. Morong.
Araliaceae: Prof. Hitchcock.
Umbelliferae: Pres. Coulter and Mr. Rose.
Cornaceae: Pres. Coulter.
Clethraceae, Pyrolaceae, Monotropaceae, Lennoaceae, Ericaceae, Diapensiaceae: Mr. F. V. Coville.
Myrsinaceae, Primulaceae, Plumbaginaceae, Sapotaceae, Ebenaceae, Symplocaceae, Styracaceae, Oleaceae, Loganiaceae: Mr. Small.
Gentianaceae: Mr. Chas. L. Pollard, U. S. Department of Agriculture.
Borraginaceae: Prof. Edw. L. Greene, University of California.
Verbenaceae: Prof. Hitchcock.
Solanaceae, Scropulariaceae: President Coulter.
Chichoriaceae, Compositae: Prof. Greene (*Aster* and *Solidago* by Prof. Thos. C. Porter, Lafayette College, Easton, Penn.

EDITORIAL.

It is hard to eliminate personal prejudice from any discussion of the nomenclature question, and as the contention proceeds extreme views seem to become more pronounced. Such a condition of things is always unpleasant, but it is necessary, and all progress is the result of contest between conservative and radical. It would be unfortunate if either spirit had its way unchallenged. What we should desire is a resultant of opinions, for no one should have the temerity to believe that his own personal views are the only ones worthy of acceptance. For this reason, it is probable that permanent good will come from the discussion now attracting so much more attention than its importance deserves.

The Gazette has been more conservative than radical, but it has always been open to conviction, and has allied itself with every movement that has promised to advance the interests of American botany. At the same time, it has repeatedly urged that ripe preparation and experience are necessary in the direction of any profitable change. One of the greatest obstacles in the way of the proposed American code of nomenclature has been the eager and hasty fashion in which it has been applied in all sorts of lists by all sorts of botanists. We are firmly convinced that the fundamental principles of the proposed code are sound and tend to permanency, but its hasty application has brought about some unwise and unwarranted changes. Nothing short of monographic study can properly apply any code of nomenclature. We question whether many of the younger botanists who are publishing in this country really appreciate the amount of critical skill and wide investigation involved in questions of synonymy. Much of the synonymy that has been handed down to us is but reputed synonymy, and when these transmitted opinions are simply juggled according to any code of nomenclature the confusion is likely to be increased.

Even if a code acceptable to all could be formulated it would take many years of study by all of our systematists to properly apply it throughout the American flora, and until it can be done with certainty it should not be attempted. An old name should stand until a thorough and competent investigation has proven it faulty. In this we are not condemning the action of the Botanical Club in directing the application of the Rochester Code by a committee to the "Manual flora." We believe that action was wise and in the result we have

illustrations of the working of the rules which will serve to clarify discussion and form a basis for future action. The "List" prepared by that Committee must not be looked upon as a list of the authorized names of our eastern plants. While the general principles of the American code are believed to be sound, certain details seem to work unhappily in that List, and certain things are left unsettled. Only careful consideration can suggest the necessary modifications. Our taxonomists ought to give serious thought to all these questions this year. We particularly commend to their consideration the propositions by Messrs. Ascherson and Engler elsewhere recounted. There should be wise action taken at Springfield this summer.

THERE IS A conservatism which means self-opinionated obstinacy, and a radicalism which means a greediness for change. With neither of these should we have any sympathy. But the conservative and the radical who are open to conviction are in the proper judicial attitude to settle this question. Our contention, therefore, is by no means against the American code, for we are partly responsible for its promulgation, but against the idea that all its details are finally settled, and more than all against its hasty and unstudied application.

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THE PROPOSED "Systematic Botany of North America" has been placed upon a sure financial basis, and work has already been begun upon many parts. The present assignment is published elsewhere in this number, covering nearly half the entire work. Whatever may be said of its general merits it marks an important stage in the co-operative spirit of American botanists. A uniform style of presentation has been adopted, that is, as uniform as widely different groups will permit; and a system of nomenclature has been outlined for general guidance. Further than this each monographer is as independent as though the work were all his own, and the work of editing will only concern itself with seeing that uniformity of style is preserved. Diversity of opinion may and does exist as to some of the rules for general guidance, but when once adopted it needs no argument to show that they must be followed. The really significant part of the work, the subject matter, is in the control of the individual monographer. As a consequence, this great work offers the largest opportunity for independent individual effort in systematic botany that has ever been given in this country. As a result, our whole flora will be passed in review as it never has been before, and the facts brought to light will form the basis of future work even though many of the opinions expressed may be discarded.

CURRENT LITERATURE.

Pharmacal botany.

For the student of pharmacy two sciences, chemistry and botany, are indispensable. Of the two, chemistry finds the most continuous application, and as a consequence students of pharmacy are given thorough courses in chemistry, pure and applied. But the botany has always suffered, and attempts are numerous to produce in the form of a text-book or a laboratory guide some short cut to what is considered a sufficient knowledge of botany to enable the student to recognize the vegetable drugs. The book before us is a manual of organic materia medica[1] with a prefatory part 1 entitled *pharmacal botany*. It is with this chiefly that we are concerned.

And we remark at the outset that Prof. Sayre's introductory section is out of date. Why should M. C. Cooke's quotation from Lankester (!) on the distinctions between plants and animals be quoted to the extent of half a page when the student is told in a footnote that these are of historic interest but is given no real information on the differences, or rather the resemblances?

The first chapter, miscalled morphology, is an illustrated glossary of the descriptive terms for phanerogams, among which the gymnosperms figure as a "polycotyledonous" division coördinate with di- and monocots.

The second chapter, miscalled structural botany, treats of the histology of vascular plants, with special reference, it is said, to the needs of the student of pharmacognosy. While the first chapter was an inadequate account of the organs of the higher plants, the second is eally ridiculous as an introduction to their histology, illustrated as it is with the antiquated—for the year 1895 the grotesque—figures from Bentley's Manual of Botany. The chapter covers 35 pages in all, of which 5½ are devoted to starches, while the remaining cell contents are treated in 3 pages; forms of cells in 1 page; systems of tissues in half a page; and the anatomy of the stem in 2 pages!

"The cavity left in the cell by its disappearance ['this protoplasm becomes assimilated'] is called a vacuole." As one method we are

[1] SAYRE LUCIUS E.:—A manual of organic materia medica and pharmacognosy; an introduction to the study of the vegetable kingdom and the vegetable and animal drugs, comprising the botanical and physical characteristics, source, constituents, and pharmacopœial preparations, with chapters on synthetic organic remedies, insects injurious to drugs, and pharmacal botany. 8vo. pp. 555. figs. 543. Philadelphia: P. Blakiston, Son & Co., 1895. $4.50.

told that "the cell divides by an ingrowth of the cell-wall:" while the only other mode of division is by free cell formation. Glands and secretion reservoirs, structures which one would suppose of great interest to the pharmacist are dismissed in 12 lines. But it is useless to go into further details. Prof. Sayre is undoubtedly competent to write about materia medica, but he is not competent to write about botany, and it is a pity that he undertook to prepare this part of his book, for it is unworthy of the larger special part and of the handsome dress in which the well known publishers have clothed it.

A manual of histology.

A new laboratory manual for classes beginning the study of vegetable histology is being perfected and will be issued after a time. It is by Professors M. B. Thomas of Wabash College and W. R. Dudley[1] of Stanford University. It is the outcome of a number of years experience and trial, first in the laboratory of Cornell University and afterward in the institutions with which the authors are now connected, In the division of labor Part I on technique and also the editorial supervision of the whole work has fallen to Prof. Thomas, and Part II on laboratory directions and also the general plan of the whole book to Prof. Dudley.

The aim of the authors is to furnish concise and detailed direction for the elementary study of cells and tissues according to the most approved methods of manipulation. The idea is to lead the student who enters the laboratory, where the microscope and microtome are the chief instruments, through a careful and well-thought-out course of instruction from the handling of a compound microscope to the preparation and examination of serial sections, and to familiarize him with the most common forms of tissues of the vegetative organs of the higher plants. Numerous references are made to standard text-books, that are likely to be found in a well equipped laboratory.

As an aid in teaching the pupil exact methods at the outset of his course, the work is admirably conceived and will doubtless meet with favor. The plates are somewhat lacking in the finish of the drawings and in their arrangement on the page, but are serviceable.

A monograph of the Mycetozoa.

If any one imagines that in our abounding zeal for histological and physiological research among the higher plants the investigation of the so-called cryptogamic world is likely to be forgotten, a glance at recent

[1] THOMAS, MASON B. and DUDLEY, WILLIAM R.—A laboratory manual of plant histology. Preliminary edition. The authors, Crawfordsville, 1894. 8vo. 115 pp. 15 pl. $1.50.

literature will certainly reassure him. To say nothing of bacteriology, which is in itself a science, work in all lines among the lower forms of life was surely never so great as now. Take even that small group of organisms, the mycetozoa, which forms the topic of the volume before us[1] and here we have treating the same subject two monographs in the English language within as many years. These two comprehensive works represent, of course, different collections; but that such works, handsome, costly works, should appear at all is evidence of the universal, cumulative interest lately roused in the organisms of which the volumes treat. The former volume dealt with the collections of Myxogastres, or, as they are familiarly called, slime-molds at Kew; the present volume treats of the collections, equally rich, which have place in the magnificent herbarium of the British Museum. Mr. Lister, the present author, has been long a student of his subject, has had access to all the largest collections, especially American collections, in the world, has the advantage of writing last, and has consequently given us the best account of the slime-molds that has so far appeared: nevertheless it is plain for many reasons that the last word on the subject has not been said. Mr. Lister, adopting De Bary's view of the relationship of the group and following the wavering authority of Rostafinski calls the organisms he discusses *Mycetozoa*. This name was substituted by De Bary for *Myxomycetes* Link, simply to express his view that the organisms in question were animals rather than fungi. Both names are bad on etymological grounds and have the further disadvantage of supplanting the old appellation *Myxogastres* Fries, which has no etymological falsity. Myxogastres ought to stand as it was correctly applied and limited.

In his arrangement Mr. Lister follows Rostafinski; but in almost nothing else; the Polander's species are thoroughly revised and a great many go down as synonyms of each other. In this revision Mr. Lister is not always consistent. For instance: the form familiar to American students as *Clathroptychium rugulosum* (Wallr.) R. is, in the face of Rostafinski's protest, *Sluzowce* p. 225, written down under the generic name *Dictydiæthalium*, adopted under mistaken conception by Rostafinski in his university studies, and committed to Fuckel for publication in *Symbolæ Mycologicæ*, 1873. Rostafinski was the first to discover his mistake, and as cited made the necessary corrections, 1874–5, and the name in general use resulted. Under the circumstances it might, one thinks, have been allowed to stand. But, now

[1] LISTER, ARTHUR:—A monograph of the Mycetozoa, being a descriptive catalogue of the species in the herbarium of the British Museum. 8vo. pp. —. pl. 78. figs. 51. London: 1894.

for specific name we must say *D. plumbeum* Rost., though Rostafinski never called the species *plumbeum! Plumbea* is the oldest specific name applied to the object, it is true; but it was under an entirely different genus, viz., *Fuligo plumbea* Schum. 1803. According to Mr. Lister's own ruling the species should now be called *D. applanatum* Rost., for that adopts "the first authentic specific name published under the genus in which the species now stands." Whatever we may think of the rule, Mr. Lister does not always observe it. The generic changes are on the whole few. *Ophiotheca* disappears, merged with *Perichæna*, and *Tilmadoche* and *Physarum* are consolidated as they should be. On the other hand we gain a new family, *Margaritaceæ*, to include the genera, *Margarita*, *Dianema*, and *Prototrichia*. The changes in the present volume, as indicated already, come in the way of consolidating species. To make too many species is not good and revision is always in order; but the crowding of too many forms under one specific name is a sin in the opposite direction, induces confusion and will by and by provoke a change. Compare, for instance, *Physarum compressum*, *Physarum berkeleyi*, etc. On the whole the book will be exceedingly useful to students. The little wood-cut sketches will generally aid in the determination of genera and many of the most common species are figured in the plates. These are in the main excellent, reproduced by photographic process from water-color drawings. As a consequence those representing species whose natural colors are black and white are reproduced best. The publication is by the Trustees of the British Museum, and they may well share with the author congratulations on the completion of a beautiful and very successful piece of thoroughly scientific work.—MACB.

Minor Notices.

THE FIRST PUBLICATION from the Field Columbian Museum,[1] of Chicago, gives an account of the founding of the museum and a brief description of its present collection, with illustrations. The botanical department is in charge of Dr. C. F. Millspaugh. It occupies the galleries, and is particularly rich in forestry exhibits. No mention is made of the rather large herbarium which forms a part of the collection, but which for obvious reasons can not be displayed. It is encouraging to botanical students that so notable a museum should put botany on an equal footing with zoology and other departments.

DR. ROLAND THAXTER has continued his publications on Laboulbeniaceae by a recent paper in *Proc. Amer. Acad.* 30: 467. The gen-

[1] Publication I. An historical and descriptive account of the Field Columbian Museum, Chicago, 1894. Vol. 1, no. 1. 91 pp. Illust.

eric name *Acanthomyces* Thaxter is changed to *Rhachomyces* Thaxter on account of preoccupation, and a seventh species added. Two new genera are established, *Diplomyces* and *Eucantharomyces*, and twelve new species are added to *Laboulbenia*. We are informed that twenty-four quarto plates, including 600 figures, illustrating these and all the other Laboulbeniaceae described by Dr. Thaxter, have been completed, and will be published as soon as suitable arrangements can be made. We sincerely hope that a publisher will be secured at an early day.

CAMPBELL'S Biology[1] is another one-sided book from the botanist's point of view. There is a chapter on plant tissues, one on plant structure, one on yeast, one on protococcus and glœocapsa, and one on bacteria (together 42 pp.). The rest is almost purely zoological, and seems to be accurate and well-put, though much condensed. The botanical part is good, what there is of it. But the book would be better without such an inadequate treatment of the life-work of plants.

A HANDY VOLUME of about one hundred and twenty pages, in pocket form, dealing with the organic drugs of the United States Pharmacopœia has been compiled by John S. Wright,[2] botanist to the large pharmaceutical establishment of Eli Lilly & Co., of Indianapolis, Ind. Over two hundred and fifty vegetable drugs are treated in a very compact but comprehensive manner. Under each is briefly stated the name, source of the drug, character of the plant, range and habitat, constituents of the drug, properties, dose and preparation. The non-pharmaceutical student would have been glad of an index. The work bears evidence of careful preparation. It is well printed and bound, and must serve a useful purpose. It is distributed by the firm, to whom application may be made, or to the author.

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[1] CAMPBELL, H. J.:—Text book of elementary biology. 8 vo. pp. xii+284. figs. 136. London: Swan Sonnenschein & Co. [New York: Macmillan & Co.] 1893.

[2] WRIGHT, JOHN S.:—A guide to the organic drugs of the United States Pharmacopœia, 1890, containing, in addition to the brief account of organic drugs, a conspectus of the natural orders of plants mentioned, and glossaries of the botanical and medical terms used. Narrow 16 mo. pp. 118. Eli Lilly & Co., Indianapolis, 1895.

NOTES AND NEWS.

THE SYLLOGE FUNGORUM by Prof. P. A. Saccardo is to be continued. Volume IX is now in preparation.

THE PLANT INDIVIDUAL in the light of evolution is the title of a paper by Prof. L. H. Bailey, read before the Biological Society of Washington on Jan. 12th.

THE MICROSCOPICAL BULLETIN will be issued by Queen & Co. for the present year as heretofore. It appears bimonthly, at the subscription price of 25 cents a year, and contains many good things for workers with the microscope.

THE MARCH NUMBER of the *American Microscopical Journal* is of special interest to botanists, inasmuch as it contains a good portrait of Dr. Samuel Lockwood, so well known among the botanical fraternity, and also an artificial key to the genera of lichens, prepared by Mr. L. A. Willson.

IF THOSE who use live marine algæ in their courses of instruction will indicate to the Cambridge Botanical Supply Co. the time of year when they need such specimens the Company propose to prepare and issue a schedule of shipments. These have been successfully made as far west as Nebraska.

THE SUMMER SCHOOL at the University of Wisconsin offers botanical instruction by Professor Barnes, Dr. R. H. True, and Mr. F. D. Heald. Courses in general morphology and experimental physiology, and special work for advanced students are offered. The school begins July 8th and closes August 16th.

IN THE summer school of Cornell University, July 8th–August 16th, botany will be in charge of Prof. Rowlee. Courses are offered in systematic botany and histology; also a "general course" consisting of lectures upon the natural groups of plants accompanied by appropriate studies in the field and laboratory.

A SUMMER SCHOOL of cryptogamic botany will be held in the laboratory of the Cambridge Botanical Supply Co., Cambridge, Mass., beginning July 5, 1895, and continuing five weeks. Laboratory work and lectures will embrace courses in general cryptogamic botany for teachers, covering recommendations of "Committee of Ten," and economic mycology for investigators, with special attention to culture methods and literature.

DR. HARVEY W. WILEY has just published an account, with plates, of the culture, properties and uses of the "sweet cassava" (*Janipha Manihot*) of southern Florida and tropical America. It seems to be an exceedingly valuable human and cattle food, yielding a large amount of easily separated starch, and well suited to cultivation in the southern portions of the Gulf states. The publication is Bulletin 44 of the Division of Chemistry, U. S. Department of Agriculture.

THE METHODS AND AIMS of the horticultural department of Cornell University are set forth with some detail in an interesting article in the *American Florist* (10: 557. 12 Ja 1895) by Mr. Michael Barker. While the methods pursued are strictly scientific and the results often of great interest to botanists, the primary design of the work is to develop the knowledge and practice of horticulture.

THE PROCEEDINGS of the Davenport Academy of Sciences (6: part I) contains an excellent portrait of Dr. C. C. Parry, and also a biographical sketch by Dr. C. H. Preston. Mrs. Parry also furnishes a complete list of titles, the number of which is much larger than botanists will expect, as Dr. Parry's writings were scattered through numerous publications.

PROFESSOR E. L. GREENE publishes a new Californian *Ceanothus* in the *Kew Bulletin* for January. The sheet of type specimens is at Kew and seems to be unique. The plants were collected long since by Lobb, probably in the Coast Range. It has probably been confused with *C. divaricatus*, but its white-glaucous branches and branchlets distinguish it, along with other characters, and suggest the specific name *leucodermis*.

AN EMERGENCY POSTER, in relation to Russian thistle, printed on a sheet 20 by 24 inches, has been sent out by the Ohio Experiment Station as a supplement to Bulletin 55, to warn farmers and acquaint them with the appearance of the much dreaded weed. Good illustrations and brief description of the weed make it easy to be recognized by every one. This method of displaying posters throughout the state, if it can be properly done, must be a rapid way to acquaint a large section of country with new facts of moment.

BOTANICAL WORK at the Department of Agriculture is developing rapidly in the number of separate organizations and is increasing in scope. The Division of Vegetable Pathology has had Physiology added to its title, an enlargement of name to cover physiological work which has been going on for some time. The Division of Grasses and Forage Plants has been newly organized, cut off from the old Division of Botany. These two Divisions, with those of Botany and Forestry, constitute a broad range of botanical investigation, and should yield large results.

A WELCOME DEPARTURE for biologists will be the division of the subject matter of the journal, *Centralblatt für Bakteriologie und Parasitenkunde*, into two separately issued parts, beginning with the present year. The first part will contain medical bacteriology and animal parasites, and the second part general, technical and agricultural bacteriology and plant diseases. It will be a saving of much labor and a great convenience to have the non-pathological portion of bacteriology free from the overshadowing and bulky pathological part, for which biologists especially will doubtless be grateful.

M. F. BOERGESEN has begun the publication in *Jour. de Botanique* (Jan. 1) of a paper on the leaves of Arctic plants. The present number contains an account of the epidermis, including the stomata and the transpiration tissues. A large list of Arctic plants has been examined

and the results are stated as follows: (1) Most arctic plants possess stomata on both leaf surfaces, the greater number being on the upper surface; (2) the stomata are situated even with the surface of the leaf; (3) the mesophyll (transpiration tissue) is a very porous structure.

In 1892 Dr. Ignatio Urban began the publication of "Additamenta ad cognitionem florae Indiae occidentalis," in Engler's *Botan. Jahrb.* The second contribution ("Particula II") of the series has just now appeared (l. c. 19: 80–199), dealing exclusively with the great and perplexing tropical family *Myrtaceæ*. The amount of synonymy in many of the species is appaling, their great variability having led the earlier students of the family to a large multiplication of species.

Anhalonium Lewinii (*Lophophora Williamsii Lewinii* Coulter) is to be reckoned among the poisonous Cactaceæ. Its alkaloid, anhalonin, has been studied by L. Lewin, after whom the species is named. Warm-blooded animals are severely poisoned by a dose of 0.02–0.04^{gm} and killed by 0.16–0.2^{gm} per kilo. The Mexican Indians use a substance they call *peyotl*, or *pellote*, as an intoxicant, and Herr Lewin thinks this cactus furnishes the material. On chemical and structural grounds he would keep *A. Lewinii* distinct from *A. Williamsii*. Besides four other species of Anhalonium, *Mamillaria uberiformis* and *Rhipsalis conferta* have been found to contain poisonous alkaloids.

In the *Bull. l'Herb. Boiss.* (Jan.) Ad. Tonduz begins a series of papers upon the botanical features of Costa Rica, the present number containing a photographic reproduction of a forest of "Indian trees." In the same number Edmond Bonnet publishes some letters from Linnaeus and his son to David van Royen, Professor of Botany at Leyden. Linnaeus seems to have had a prodigious correspondence, no less than 163 botanical correspondents having been listed. If he wrote to them all as fully as in the case of the letters before us it is difficult to understand how he found time for investigation. About 400 of his letters are known, but the vast majority seem to have disappeared.

The herbarium of Mr. Walter Deane, of Cambridge, is one of the most interesting collections in the country. Mr. Deane has confined himself to what may be known as the "Manual" plants. He has not merely tried to make a collection of excellent specimens of the ordinary sort, but he has undertaken, so far as material has been accessible, to represent on his sheets all the various stages of development. As a consequence, his collection has become full of valuable information with reference to the growth of many species. It is a matter for congratulation that Mr. Deane has consented to publish some of the facts which have thus been gotten together in his herbarium.

A sketch of Thomas Nuttall, with portrait, appears in *Pop. Sci. Monthly* for March. The large impress he left upon American systematic botany is becoming better recognized than formerly. Not only was he the indefatigable explorer of a new flora, but a man of rare discrimination in the matter of genera and species, of which he is said to have described more than any other writer on American plants, excepting Dr. Gray. He was born in Yorkshire, England, in

1786, became a printer by trade, came to America in 1808, where he resided for thirty-four years, chiefly in Philadelphia and Cambridge (Professor in Harvard College, 1822–1833), taking several extended trips, returned to England in 1841, and died there September 10, 1859.

PARTS 111 and 112 of Engler and Prantl's *Die natürlichen Pflanzenfamilien* contain the Araliaceæ by H. Harms, the Jungermaniaceæ akrogynæ (concluded) and Anthocerotaceae by V. Schiffner, and the Musci (Laubmoose) begun by Carl Müller. Schiffner gives the following summary of the Hepaticae (up to July 1893): Ricciaceae, 4 genera, 110 species, of which 3 genera and 28 species are found in Europe; Marchantiaceae, 22 genera, 165 species, of which 17 genera and 28 species are European; Jungerm.-anakrogynae, 19 genera, 266 species, of which 12 genera and 34 species are European; Jungerm.-akrogynae, 116 genera, 3,321 species, of which 53 genera and 232 species are European; Anthocerotaceae, 3 genera, 103 species, of which 2 genera and 10 species are European.

THE INDIANA Academy of Sciences held its tenth annual meeting at Indianapolis on December 27th and 28th. Of the eighty-nine numbers on the program, thirty-one were botanical subjects, or 35 per cent. The officers elected for 1895 are Mr. A. W. Butler, president, and Mr. John S. Wright, secretary. The Iowa Academy of Sciences held its ninth annual session at Des Moines on the same dates. Of the fifty-five numbers on the program, eleven were botanical, or 20 per cent. It should be noted, however, that three were only to be presented "by title," i. e., were not to be read. The Ohio Academy of Science held its fourth annual meeting at Columbus on December 27th and 28th. Of the fifty-three numbers on the program, nineteen were botanical subjects, or 36 per cent.

THE REPORT of the Gray Herbarium for the year 1893–94 (September to September) contains the following items of general interest. Plants received, 8,787; number of sheets added, 9,675; number of volumes added to library, 231, of pamphlets, 241. The botanical collector for the Herbarium, Mr. Pringle, with two assistants, is exploring Oaxaca, reputed to be the richest region of Mexico botanically. Dr. Robinson and Mr. Schrenk collected for six weeks in Newfoundland, and brought back some very interesting material; collections and library have been card-catalogued; work on the "Synoptical Flora" has about closed the largest gap (*Cruciferæ*) left in Dr. Gray's manuscript of the first volume, which is to include *Ranunculaceæ—Leguminosæ;* L. H. Bailey's revision of "Field, Forest and Garden Botany," is announced for January, 1895.

THE INSECT THEORY to account for the disease of potato tubers known as "scab," had been completely overthrown, as every one thought, by the bacterial theory, now fully established as fact. Yet at this late time we are shown by Mr. A. D. Hopkins (Proc. Ent. Soc. Wash. 3: 149) of the West Virginia Experiment Station, that one form of the scab may certainly be produced by a small gnat, about a millimeter long, the larvæ which are the depredators being four times that length. The larvæ eat into the potato wherever the periderm is

injured. The investigator scratched his initials upon a potato tuber and the insects (Epidapus scabei) turned the injured surface into a scab mark, in a similar way to Dr. Thaxter's well-known initial-mark test with bacteria (Oospora scabies). The distribution of the gnats outside of West Virginia has not yet been ascertained.

MR. O. F. COOK is expected to return to this country in May from his rather extended African sojourn. Mr. Cook is in the employ of the American Colonization Society, and his nominal duties are the foundation of an agricultural and mechanical school to which the Liberian government has donated a tract of 1,000 acres for an experimental farm in the interior of the country. He has, however, sufficient time and freedom in which to make large collections, and will return with much valuable material, especially cryptogams. His first visit to Liberia was in 1891–2. After spending a few months in America, during which he married Miss Alice Carter, known to our readers by her contributions to our pages on the subject of pollination, he returned to his African duties in October, 1893, accompanied by Mrs. Cook. The last rainy season, ending in December, was spent in the Canary islands where he has also made some collections.

PROFESSOR JOHN MACOUN has published in *Trans. Roy. Soc., Canada* (Section IV, 1894) a paper on the forests of Canada and their distribution, with notes on the more interesting species. He speaks very strongly of their ruthless devastation, and gives many unhappy results of this vandalism. The following regions are discussed separately: subarctic belt, Prince Edward Island, Nova Scotia and New Brunswick, Quebec, Ontario, Manitoba and the Northwest Territories, Rocky Mountains and British Columbia, Vancouver Island. Some very interesting remarks are made on the distribution of certain species, and the changes observed in those which have an east and west continental distribution. He states that, including Vancouver Island coniferous forest extends from the Pacific to the Atlantic, bounded on the north by the tundra of Alaska and the Barren Grounds of the Dominion, and southerly with a varying border until it meets and intermingles with the poplar forests of the Northwest Territories, and eastward with the deciduous forests of Ontario, etc. He estimates this huge forest belt as containing about a million square miles.

AN EXPLANATION of the appointment of an International Committee on Nomenclature by the Genoa Congress (1892) was given by Ascherson and Engler at the Vienna meeting last September. This paper now comes as a separate from *Oesterr. bot. Zeit.* 45: 27. 1895. A review is given of the recent nomenclature discussion, the unhappy results of various extreme views are pointed out, and the following suggestions are offered for consideration: (1) That the rule for homonyms be recommended for future guidance, and be not made retroactive; (2) that in the generic transfer of a species the original specific name be retained according to the rule; (3) that the year 1753 be the datum-line for priority of both genera and species; (4) that while the principle of priority shall be used in the naming of the species a safe name shall not be replaced by a doubtful one; (5) that in the naming of genera, a name which has been ignored for at least

fifty years shall not replace one which has been in use during that time; (6) that an exception be made to this rule in the case of generic names that have been in use at least fifty years since their restoration.

PROFESSOR L. H. BAILEY, in a recent address before the Biological Society of Washington, discussed the subject of the plant individual in the light of evolution. He suggests the idea that both Lamarckism and Darwinism are true, but that the former finds its expression best in animals and the latter in plants. His chief points, however, are: (1) that the plant is not a simple autonomy, in the sense in which the animal is; (2) that the plant parts are independent in respect to propagation, struggle for existence, and transmission of characters; (3) that there is no essential difference between bud-varieties and seed-varieties; (4) that all these parts are at first sexless, and finally may or may not develop sex; (5) that much of the evolution of the vegetable kingdom is accomplished by wholly sexless means.

Professor Bailey's conception of a plant, therefore, seems to be that it is a colony of potential individuals, each one of which is capable of working out its own independent development under the various influences of environment. If this be true there can be no localization or continuity of a germ plasm in the sense in which these conceptions are applied to animals.

FROM ADVANCE sheets of the Report of the Missouri Botanical Garden we take the following: The financial results for the past year have been very satisfactory considering the depressed condition of trade. The surplus Dec. 31, 1893, amounted to $40,649.75; $19,824.18 have been added in 1894, making the total surplus $60,473.93. No extensive improvements have been made, but the addition of a plant-house 21×97^{ft}, costing about $2,700.00 and several granitoid ponds for the growing of the Victoria regia and other lilies have added greatly to the beauty and attractiveness of the Garden. The fruticetum has been further improved this year by the removal of all of the old and worthless apple trees and grape vines and is to be largely replanted in the spring to carefully selected varieties of fruit. While much remains to be desired, the labeling of the plants of the Garden is being greatly improved each year. The enamel (granite ware) tree labels which were at first tried have not proved satisfactory, and trees of sufficient size are now receiving zinc alloy labels cast with raised letters, affixed by two pins in a vertical line so as to admit of the expansion of the tree during growth. For the smaller plants, celluloid labels, lettered with a special ink, have been employed very largely. The herbarium has been increased by the incorporation of 9,307 sheets of specimens, of which 3,567 sheets were purchased, 126 belonged to the Bernhardi herbarium, and 5,614 were received by donation or exchange. About 1,220 duplicates have been distributed to correspondents by way of exchange. As now constituted, the herbarium contains about 231,527 specimens. The additions to the library consist of 373 books and 166 pamphlets purchased, and 379 books and 999 pamphlets, donated or received by way of exchange. Exclusive of the Sturtevant pre-Linnean collection of about 460 volumes, the library now contains 7,631 books, 9,822 pamphlets, a total of 17,453 works, and 110,000 index cards, exclusive of the author catalogue.

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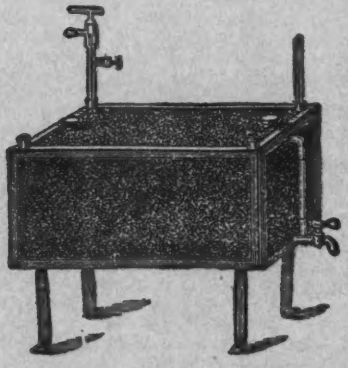

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